

ANNUAL REPORT  
OF THE  
GOVERNOR OF  
THE PANAMA CANAL

FOR THE  
  
FISCAL YEAR  
ENDED JUNE 30  
1916



WASHINGTON  
GOVERNMENT PRINTING OFFICE  
1916

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ANNUAL REPORT  
OF THE  
GOVERNOR  
OF  
THE PANAMA CANAL.

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THE PANAMA CANAL,  
OFFICE OF THE GOVERNOR,  
*Balboa Heights, Canal Zone, September 11, 1916.*

SIR: I have the honor to submit the annual report covering the construction, operation, maintenance, sanitation, and protection of The Panama Canal for the fiscal year ended June 30, 1916.

**CONSTRUCTION.**

The department of operation and maintenance, under which all construction work was done, continued in charge of the Governor, who was assisted in the administration of the department by the engineer of maintenance, Lieut. Col. Chester Harding, United States Army, and by the marine superintendent, Capt. Hugh Rodman, United States Navy, until October 1, 1915, when he was succeeded by Commander H. I. Cone, United States Navy.

The principal construction work carried on during the year was done in connection with the terminals, and the erection of buildings for various purposes; the electrical, municipal, and dredging divisions did a large amount of construction in connection with both the terminals and the new buildings.

**DIVISION OF TERMINAL CONSTRUCTION.**

The division of terminal construction, under Rear Admiral H. H. Rousseau, United States Navy, was charged with the design and construction of dry docks, shops, coal and fuel oil plants, floating cranes, docks, and other terminal facilities; the inspection of machinery and appliances under contract pertaining to these various objects; and the construction of the east breakwater of Colon Harbor. On account of the practical completion of the work, this division was abolished effective May 31, 1916, and since that date the remaining construction and inspection forces were placed under the engineer of maintenance. Admiral H. H. Rousseau was relieved from duty with The Panama Canal effective July 7 1916.

*Dry docks.*—The construction of the dry docks was undertaken, with the authority of Congress, when it became apparent that, because of the lower unit costs secured during the construction of the canal than were used in the preparation of the estimates, there would be sufficient money for the purpose. Following the views advanced by the Navy Department, two dry docks were contemplated, located on the Pacific side—Dry Dock No. 1 was designed and built of sufficient size to admit any vessel that can use the locks (the dimensions are given in detail in the annual report for 1915)—and Dry Dock No. 2, 350 feet long and 59 feet wide, for smaller craft. As the construction was authorized in view of the possible savings, when it became evident that both dry docks could not be built and the canal completed construction on No. 2 was stopped, but it was left in such shape that it can be readily completed at any time should it be deemed necessary.

Early in the fiscal year the excavation and cleaning of the rock in preparing foundations for Dry Dock No. 1 were completed. Most of the mass concrete had been placed by the end of the last fiscal year; that remaining to be done was at the entrance on either side, the pump well, and the opening in the wall which was left to accommodate the mixing plant. The reinforced concrete still to be placed was for the several machine rooms, the copings, drains, gutters, numerous small lots around the metal parts and the coping lever. The permanent mixing plant used in the construction of the dry dock remained in service until the latter part of August, 1915, when it was removed and the mixers mounted on cars fitted with towers and chutes for delivering the concrete into forms. The trestle leading into the dry dock was dismantled in December, 1915. The floor was finished in January, 1916, with the exception of the traverse slots for the keel and bilge blocks, which were subsequently cut in the concrete. There were placed 12,897 cubic yards of mass concrete and 17,757 cubic yards of reinforced concrete, in which 1,043,366 pounds of reinforcing steel and 1,122,236 pounds of fixed steel were embedded. The average cost of the mass concrete was \$5.5882 per cubic yard and of the reinforced concrete \$7.7338 per cubic yard. The low cost compared with concrete placed in the locks is due to the use of sand and gravel secured from the Chagres River, not accessible until the lake reached its full height.

The granite blocks forming the miter sill and the quoin posts were set during the year; the granite seat for the floating caisson was also put in place and finished off. Great care was exercised in dressing down for final surfaces, and special steel templates were prepared for the purpose. When finished, the maximum variation of the granite sills from a true plane was one thirty-second of an inch. Granite amounting to 425.41 cubic yards was set, at a total cost of \$847.87 per cubic yard.

The miter gates to the dry dock are of the same design as those used in the locks, and the various members and plating were furnished by the same contractors, the McClintic-Marshall Construction Co. The erection and riveting were done by hired labor. The south leaf was erected, riveted, and placed on its pintle by November 27, 1915, and the north leaf by December 14, 1915. The cost of erecting the gate leaves, exclusive of the greenheart, was \$98.9205 per ton. The miter posts and the quoin posts are of greenheart timber obtained from British Guiana. The gates will finally receive a coat of bitumastic solution and one of enamel.

The machinery for the pumping plant for unwatering the dock was furnished by Henry R. Worthington under contract. It was completed by the close of the fiscal year and tested out subsequent thereto; the results were very satisfactory as its efficiency was in excess of that specified by the contract. The cost, including the bonus earned for increased efficiency, amounted to \$151,476. The flooding and sluicing valves are complete, and the dry dock is in condition for use.

*Entrance basin.*—No excavation was necessary in the entrance basin during the year, except some hand work in connection with placing a concrete apron in front of the entrance of Dry Dock No. 1, and leveling the bottom of this basin so that it would all be below elevation minus 45. The amount excavated was 1,300 cubic yards, at a cost of \$1.3009. All tracks and other material were removed prior to April 1.

*Cofferdam.*—The cofferdam, which kept out the water from the area occupied by the dry dock, unloader wharf, entrance pier, and basin, during construction, was drilled for blasting during February, March, and April. Sufficient drilling was done by April 1 to permit an opening to be blasted through the cofferdam approximately 180 feet wide. In blasting, care was exercised so as to protect the completed work from injury. No dredges were available until toward the close of the fiscal year, when an opening was made sufficiently large for the docking of the *Corozal*, one of the units of the dredging fleet, on June 27, 1916.

*Entrance Pier No. 9.*—The gravity wall, which was designed to form the south wall of proposed Dry Dock No. 2, was completed last fiscal year. Of the length authorized, there yet remained the head-wall and the concrete steel decking. These were completed in March, 1916. In January an extension of 131 feet at the outer end of this wall was authorized; this extension consists of a steel and concrete deck supported on monolithic concrete piers. In addition a curtain wall was built so as to facilitate the completion of Dry Dock No. 2 should it be undertaken. This extension was completed before April 1, and required the placing of 5,338 cubic yards of mass and 3,984 cubic yards of reinforced concrete, the average cost of which was \$6.0529 and \$8.8442 per cubic yard, respectively.

*Balboa coaling plant.*—This plant, a description of which is given in previous reports, occupies an area of 9.4 acres, of which 350 by 300 feet is constructed for the subaqueous storage of coal, with a bottom elevation of 18 feet below mean sea level; the balance of the inclosed space has an elevation of 10 feet above mean sea level, and is available for leasing to private interests. The work performed during the year on the coaling plant consisted of a continuation of the construction of the coal pockets and wharves, and the erection of coal-handling machinery under contract. The Panama Railroad tracks were removed from the site of the east coal pocket, the excavation in the pocket completed, the floor leveled and riprap retaining walls built in. There were excavated 1,760 cubic yards of rock, at \$0.3936 per cubic yard, and 1,636 cubic yards of concrete laid, at a cost of \$10.1749 per cubic yard. Prior to flooding the subaqueous storage pocket, cross-sections were taken from which the capacity of the pocket could later be computed.

*Unloader wharf, Dock No. 7.*—At the close of the previous fiscal year, the unloader wharf was completed up to the point where it intersects the cofferdam, or about four-fifths of its length. The wharf is constructed on piers resting on solid rock with decking of steel incased in concrete. To carry the wharf construction through the cofferdam without admitting water, interlocking sheet steel piling was driven and the area occupied by each pier thereby inclosed. To get the piers to proper grade, it was necessary in some cases to resort to caissons. All foundations were completed in March and the floor system in April. There were placed during the year 4,835 cubic yards of mass and 2,483 cubic yards of reinforced concrete, at a cost of \$5.2984 and \$8.3116 per cubic yard, respectively.

*Reloader wharf, Dock No. 6.*—At the close of the last fiscal year most of the cylindrical piers were finished; those remaining were near the junction of the unloader and reloader wharves, and the 8-foot diameter piers under the wharf bunker. Two difficulties were encountered in working the 8-foot cylinders: (1) When the toe reached stiff clay the frictional resistance became so great as to prevent further driving of the shell, and (2) at about 50 feet below ground level the pressure on the shell was great enough in several cases to crush the caisson. To overcome the difficulties, a short caisson, 7½ feet in diameter with heavily reinforced toe, was inserted; an angle bar with iron brackets was riveted around the inside at the top to strengthen it, and bolted sections of 6-foot caissons set on it to act as a "follower" on which to rest the driving hammer. The crushed section of 8-foot shell was cut and removed, after which the inner cylinder was sunk without much difficulty. To overcome the outward thrust from the back fill, steel rods were used to tie the wharf to an anchorage buried in the fill 90 feet to the rear; for the north half



of the dock this anchorage is a continuous concrete wall 6 feet wide by 9 feet high, supported on two rows of wood piling. To minimize the thrust still further, the back fill is sloped  $1\frac{1}{4}$  feet horizontally to 1 foot vertically from a line 25 feet back of the wharf, the slope being ripped down to low water. There were driven during the year 1,693 linear feet of 6-foot and 184 linear feet of 8-foot caissons and 61 linear feet of 4-foot caissons. Concrete filler in the substructure consists of 6,182 cubic yards, and in the superstructure of 4,757 cubic yards, all of which was reinforced, and was placed at an average cost per cubic yard of \$7.4154 and \$9.1686, respectively.

*Coal-handling plant.*—The unloader towers, as a part of the coal-handling plant, were completed in their essential parts. The reloader towers, and the conveyor system, were completed but the machinery was not all installed. The rehandling plant consists of the berm cranes used for laying concrete during the construction of the Pacific locks. They have been reerected and are ready for operation.

*Repair wharves and commercial pier.*—The two remaining caissons of Dock No. 13, quay walls C-D-E, were finished and the floor slab poured early in the year. Later an extension was authorized necessitating the placing of 21 more 6-foot caissons, and also caisson supports for the crane tracks from the dry dock to Dock No. 13, requiring seven 6-foot and five 4-foot caissons. All of these foundations were finished by the end of December, 1915. Delay in receipt of steel has delayed the completion of the wharf. The average cost of excavation in caissons was \$2.6519 per cubic yard, and the average cost of concrete filler, including reinforcement, was \$6.1334 per cubic yard.

Fill was placed behind Dock No. 14, quay wall E-F, consisting of Sosa Hill rock plowed off Lidgerwood cars from a track near its rear face. The anchorages were all put in place, the ground leveled, the piping installed, and the permanent tracks brought to their final level.

Pier No. 18 is for commercial use; it is the first of a series shown on Plate No. 93, accompanying the annual report for 1915, for the development of Balboa Harbor, should additional facilities be required on the Pacific side. The back fill in the central portion, between the inner rows of cylinders, resting on the soft underlying mud, caused a slight spread at different points along the pier. This was overcome by taking out the top of the fill and placing two additional  $3\frac{1}{8}$ -inch tie-rods to each bent, with four sets of bands of heavy steel plate encircling the caissons forming bents Nos. 20, 25, 30, and 35. A double row of piles was also driven around the entire inner face of the deck slab, on which was placed a concrete wall to retain the back fill, which was composed of coral rock, a relatively light material. The shed or covering of the dock is completed and necessitated the erection of 1,930.5 tons of steel, at a cost of \$15.5436 per ton, and the placing of 1,390 cubic yards of concrete, at a cost of \$24.8202

per cubic yard. The roof is of tile similar to that placed on the shops' buildings. Sliding doors furnished by J. Edward Ogden Co. complete the inclosure of the pier. The cost of the pier, exclusive of dredging, was \$1,028,399.34.

*Reinforced concrete pontoons.*—It was decided to construct the four reinforced concrete pontoons or barges to be used as small-boat landings in slips Nos. 17 and 19, Balboa, on the floor of the dry dock, this being the most convenient location for the purpose. The dimensions of the pontoons are 120 feet 6 inches long by 28 feet 2 inches wide by 7 feet 10 inches deep, and they were designed to float with a 3-foot freeboard. The entire bottom, sides, interior bulkheads, and frames up to a height of 6 feet, or 2 feet from the top, were cast in one continuous pour. The pontoons complete, with all accessories, cost \$44,111.76. After the forms were stripped the sides were water-proofed by the "Sylvester process."

*Cristobal coaling plant.*—The Cristobal coaling plant is constructed at the north end of the island formed by the French Canal and The Panama Canal as now constructed. It occupies an area of 19 acres. Of this an area 307 feet by 500 feet is for the subaqueous storage of coal, the bottom of this area being at 28 feet below mean sea level. The rest of the area had been filled in and leveled off at elevation 2 feet above mean sea level with material excavated by the dredges along the sides of the wharves constructed as part of the coaling station. This area is provided for leasing to private coal dealers, as the policy adopted does not contemplate the United States creating a monopoly on coal for vessels utilizing the canal—merely as a regulator of prices.

The wharves on three sides of the area reserved for subaqueous storage are constructed by 6-foot diameter steel cylinders driven to hard rock, excavated and filled with concrete reinforced with vertical steel rails. The caissons for the end wharf were completed in December, 1915, thereby finishing the substructure. Much difficulty was experienced with two of the caissons under the wharf bunker, which collapsed in August, due to heavy pressure on the north side. After unsuccessful attempts had been made to drive 8-foot cylinders in their places, the design was changed by substituting 6-foot cylinders driven one on each side of the two 8-foot cylinders, and connecting them after they were driven, excavated and filled with concrete by a heavy steel girder upon which was placed the main girder for the floor system. The foundations of the wharves consist of 312 six-foot diameter steel cylinders driven to hard rock, as described in the last annual report. To fill these cylinders 20,917 cubic yards of concrete were required, and were placed at a cost of \$4.7930 per cubic yard. The concrete floor of the end wharf was completed in January, 1916, which completed the floor system of the area surrounding the coaling

station. A system of floating fenders was installed to breast vessels about 5 feet away from the concrete docks. An oil pipe was laid along each side of the plant across the end wharf and across the French Canal connecting with the oil supply at Mount Hope. This oil line was provided with suitable outlets, so that fuel oil can be supplied to vessels lying alongside. Similar arrangements were made for supplying water to vessels. For the reinforced concrete floor slab and the encasement of floor girders 17,211 cubic yards of concrete were laid, at a cost of \$4.6351 per cubic yard.

During the year the dredging division completed the excavation to minus 41, a slip 250 feet wide along the unloader wharf, all the entrance basin and berthing space along the wharf, and approximately 80 per cent of the slip 300 feet wide along the reloader wharf. Under the wharves coral rock and sand were pumped so as to form a retaining wall between the cylinders to 2 feet above mean sea level, to afford a protection to the coal in subaqueous storage against wave action.

The plant to operate in connection with this coaling station consists of four unloading towers, two stocking and reclaiming bridges, steel viaduct and reloader towers, together with a conveyor system for the wharf bunker. The coal-handling machinery and accessories are being supplied under contracts with Augustus Smith and the Hunt Construction Co., the latter company furnishing the unloading towers. Arrangements were made looking to the completion of the unloading towers ready for operation by September 1, 1915, and the desirability of using these for handling coal to ships before the rest of the plant was completed resulted in a modification of the contract providing for the addition of two loading-out chutes to each unloader tower, at an aggregate cost of \$5,140. The expectation as to the completion of the unloading part of the plant was not realized, for it was not completed until February, 1916. The tests of the unloader towers were commenced February 28, 1916. Owing to the fact that a number of adjustments and modifications were considered necessary to correct defects and deficiencies in order to secure compliance with the specifications, the towers were not accepted, nor have they yet been accepted by The Panama Canal. The balance of the plant is practically completed but not accepted.

*East breakwater.*—The east breakwater was undertaken to break up the waves created by the trade winds, so that barges and small boats might lie safely alongside ships anchored in the harbor for purposes of coaling, delivery of supplies, and transfer of passengers. It is a detached breakwater 6,741 feet in length, the outer end 2,000 feet from the extremity of the west breakwater, and the inner end, as now constructed, 4,500 feet from the shore at Coco Solo, this point being determined by the configuration of the shore and adjacent shoals,

which will assist in breaking up the waves. Its outer end is bent back, forming an ell 235 feet long.

The rock used in its construction was taken from Sosa Hill, on the Pacific side, from which was also procured such armor rock as could be economically quarried, the rest of the armor being supplied by concrete blocks manufactured especially for the purpose. The core rock, dumped from either side of a double trestle, left a depression between the two mounds thus formed which was filled by coral rock and sand, placed by a suction dredge operating in the vicinity of Coco Solo.

Prior to the beginning of the year the trestle used in constructing the breakwater had been washed away, as noted in the previous annual report, by two northers, and the salvaging of trestle material was continued until October 16, 1915. A large amount of material was recovered and used again. Work on the new trestle was completed on October 7. A single track trestle, 444 feet long, was built for the ell, and 1,644 linear feet of double track were driven, equal to a total of 1,866 linear feet of double-track trestle, in which 101,530 linear feet of piling were used.

Quarry operations were begun as soon as the condition of the trestle warranted, and in order to procure as much armor rock as possible, the quarry was operated on two levels. During the year 503,659 cubic yards of rock were excavated, at an average cost of \$0.5803 per cubic yard, of which 359,472 cubic yards of core and 62,389 cubic yards of armor rock were shipped to the east breakwater. In securing this rock 7,433 cubic yards were removed in stripping.

The amount of wet fill handled by the dredging division and placed in the body of the breakwater aggregated 326,213 cubic yards, of which 155,036 cubic yards were placed during the year. In addition, 134,502 cubic yards were pumped along the trestle connecting with the shore to give it lateral stiffness. As it was not possible to make the base of the breakwater sufficiently broad by dumping rock from the trestle, when the core-rock fill was completed the toe of the slope on the harbor side was extended by dumping hard dredged material from scows and by pumping coral rock and sand from a borrow pit near the shore at Coco Solo. The scow material was obtained from excavation near the Cristobal coaling plant, and amounted to 145,257 cubic yards. The material pumped in place aggregated 541,857 cubic yards.

To secure the armor rock necessary for the breakwater from the Sosa Hill quarry would have required wasting a considerable amount of additional material, which would have added greatly to the cost of the armor, and there was no suitable locality in the vicinity of the quarry where the waste material could be dumped. An exam-

ination of the relative costs led to the conclusion that it would be cheaper to substitute for this rock concrete blocks. A contract was entered into for the manufacture of 10,000 of such blocks, measuring 7 feet on the side, containing 12.3 cubic yards, and weighing about 50,000 pounds, at a cost of \$0.385 per cubic yard. Under this contract there were delivered and placed in the east breakwater 6,182 blocks, and 590 blocks were used in repairing the west breakwater, which was damaged by the norther during the previous year. The material used was run-of-bank Chagres gravel, with cement in the proportion of about 6 to 1. This mixture was subsequently changed to  $4\frac{1}{2}$  to 1. Progress under the contract for blocks was not satisfactory, and in order to increase the supply of blocks over those secured under contract the manufacture of blocks by hired labor was undertaken at Coco Solo and at the coaling station by the terminal division. The blocks manufactured at the coaling station for the breakwater were 5 feet 3 inches on the cube, containing 5.3 cubic yards. The mixture was run-of-bank gravel and cement,  $4\frac{1}{2}$  to 1. Those manufactured at Coco Solo measured 6 feet 3 inches on the side, containing 9 cubic yards each of the same mixture. The total number of blocks manufactured at Coco Solo was 3,644, at a cost of \$3.6810 per cubic yard, and at the coaling station 4,121, at a cost of \$3.9934 per cubic yard.

The terminal division had supervision over the construction of Pier No. 7 for the Panama Railroad Company. The dock, with the exception of the shed, was practically complete at the close of the year; the total amount expended was \$1,366,815.02; there remains, to complete the pier for operation, the erection of the shed, which is now in progress.

For further details concerning the work of terminal construction attention is invited to Appendix C.

#### BUILDING DIVISION.

The building division continued in charge of Mr. George M. Wells, resident engineer, and was subdivided for administrative purposes into five districts, as outlined in the previous annual report, until September 1, when, due to the advanced stage of the work, the Fort Amador District was consolidated with the Southern District, thereby reducing the number to four.

The division had charge of the construction of all new buildings for the canal and the Panama Railroad, maintenance and repair of existing canal and Panama Railroad buildings, where such repairs exceeded \$50 in cost for any one item, and the construction of buildings for the Army covered by appropriations for barracks and quarters.

The method adopted last year of constructing each building by what may be termed the "single-unit organization," as outlined in

the annual report for 1915, was continued, and the results obtained fully justified the change from the previous method of swinging different gangs from building to building. With a foreman in charge of each building, responsibility is fixed and a healthy rivalry created with resulting economy of construction.

In 1908, after the building division as it then existed was disbanded, a number of the foremen remained on the Isthmus and were without work. They were willing to furnish labor and erect buildings by contract, and it was found that frame buildings could be constructed more cheaply by this method than by hired labor. As the building program for the year was a large one, with additional work of the same character estimated for the current year, it was decided to ascertain whether the contract method would be the cheaper under conditions existing at present. Consequently, contracts were let for the construction of four 4-family frame houses and two 4-family concrete houses. These were located on the same streets as houses of the same types erected by canal forces, and the conditions were identical. The results show a material saving in both types of construction by doing the work by the hired-labor method. Subsequent to the completion of the contracts all buildings were constructed by hired labor exclusively, while the costs, if anything, have been still further reduced.

The first concrete buildings erected were of hollow concrete blocks, investigation showing this method to be cheaper than hollow tiles, and it was believed that solid concrete walls would be too damp for this climate. Plaster and stucco made the concrete block construction more expensive than poured reinforced concrete. Walls of concrete, by proper treatment, can be made waterproof; reinforced concrete is more substantial and resistant to earthquakes; and the concrete block construction has been displaced by poured reinforced concrete for main walls and floors, with blocks for partition walls only. To avoid the expense of white plaster, the interior of all concrete buildings are now finished in cement, the surface being treated mechanically and painted in suitable colors.

The manufacture of hollow concrete blocks was continued until December, 1915, at which time the plant was closed down. The change in design and construction of concrete buildings eliminated the necessity for blocks in larger sizes than 3 inch by 12 inch and 4 inch by 12 inch, and arrangements were made to consolidate and reduce the size of the plant. Some of the machines were modified so as to produce blocks of the useful dimensions.

The use of corrugated iron for roofs of frame buildings has been standard on the Isthmus from the beginning of canal operations. For temporary frame buildings, subject to removal and reerection, this material is most satisfactory, but for buildings of a temporarily

permanent character, intended to remain for the full life of the frame, 12 to 15 years at least, corrugated iron is not so satisfactory in that it deteriorates rapidly, is a source of expense for upkeep, and is unsightly. After careful consideration and experimentation with various kinds of roofing material it was decided to adopt the red asphalt shingle as the most satisfactory for our purpose, first cost, maintenance, and durability being considered.

At the beginning of the fiscal year 60 buildings of various kinds were under construction. During the year these were completed and 68 additional buildings were commenced for the canal and the Panama Railroad. For the Army 43 buildings were under construction July 1, 1915. These were completed and 43 more were commenced during the year under the additional appropriation that became available.

Of the Panama Canal buildings the hospital groups were the largest. The hospital buildings, at the beginning of the operating period, were in such condition that some were deemed unsafe for further occupancy, and all were in a dilapidated condition, the greater number at Ancon and those at Colon having been taken over from the French, and therefore in use for a number of years. Estimates were prepared and submitted to Congress for rebuilding the entire plant within a period of five years, and the first appropriation was made available for beginning the work at Ancon and for the construction of a hospital at Colon. The money for the Ancon unit was applied to two ward buildings, 40 feet by 138 feet, accommodating 29 patients in each ward, with porches entirely surrounding them. A service section, 32 feet by 92 feet, connects these two ward groups, providing toilet accommodations, a dining room, nurses' rooms, and special rooms on each floor. All of the exterior and interior walls of less than 6 inches were made of reinforced concrete, and the others were built up of cement blocks with a hard smooth cement-plaster finish. The floor slabs were constructed of reinforced concrete and most of the rooms were provided with red or white tile floors. All of the interior walls and ceilings were treated with enamel washable paint, which gives a pleasing effect to the interior and makes a sanitary building. The roof of yellow pine, covered with red vitreous tile, and having suitable copper ventilators, is arranged to keep a good circulation of air throughout the roof space. The building was completed and occupied by the close of the fiscal year, at a cost of \$129,182.50. A new crematory was constructed at Ancon on a site selected by the hospital authorities and approved by the health department, notwithstanding the objections raised to its location. The cost was \$13,126.24.

The Colon Hospital was completed on April 10, 1916. In order to meet the local climatic conditions, the pavilion scheme was adopted,

which divides the group into four distinct units with intercommunicating passageways. In the central unit are located the operating suite and administrative offices. It is 45 feet wide by 53 feet 6 inches long, with an extension in front 24 feet by 20 feet 4 inches, which forms a covered entrance way and makes provision for an operating room on the second floor with exposure on three sides. The ward buildings, approximately 40 feet by 120 feet, on either side of the central unit, are divided into various wards and provide rooms with a total capacity of 50 patients. The general-service building, 41 feet by 83 feet, comprising the kitchen, dining rooms, and helpers' quarters, also has a central location directly in the rear of the administration unit. All exterior porch and intermediate walls 6 inches and over were constructed of reinforced concrete and interior walls having a thickness less than 6 inches of cement block covered with smooth hard cement finish. The roof is similar in construction to the Ancon building. The cost of the hospital was \$172,169.70.

A new building, covering an area of 147 feet 8 inches by 42 feet 8 inches, was constructed during the year at Balboa, in close proximity to the piers and docks of the Pacific terminal of the canal as a terminal building at a cost of \$70,594.76. It is for the general offices of the receiving and forwarding agent of the Panama Railroad, the captain of the port, and pilots' dormitories. It is three stories in height, the first being utilized by the Panama Railroad, the third by the captain of the port, while the second story is divided into offices, which are rented individually or en suite as offices for various steamship companies using the canal.

A new ice plant was constructed for the Panama Railroad commissary at Balboa and a new laundry at Ancon. Both are of reinforced concrete and cost \$130,683.79 and \$73,000, respectively.

Extensive repairs were made to the old Ancon Administration Building. The porches were badly ant eaten and rotted, as were the floor and other parts of the building. It is now in good condition, reinforced concrete being used wherever practicable. The renovation cost \$27,960.85. It is utilized in part by the District Court of the Canal Zone and offices for the court officials, by the special attorney, and the rooms not needed by the canal are at present utilized as headquarters of the Army.

The office and store building, in connection with the Cristobal coal-ing plant, was constructed by the building division, as were also the needed buildings in connection with the dry dock and the coal bunker at Balboa.

When the appropriation for the construction of barracks and quarters for the Army was turned over for expenditure by the canal forces, plans for the barracks were made in accordance with types furnished by the Quartermaster Corps, United States Army; and the types of



quarters were determined by a board of officers consisting of Col. William F. Blauvelt, Lieut. Col. Charles F. Mason, Maj. B. T. Clayton, Maj. William E. Cole, and Capt. R. E. Wood. The building program was in accordance with the estimates submitted as the basis for the appropriation. In addition to completing all those estimated, from the same appropriation quarters were provided for the Commanding General and his staff and such other buildings as were authorized by the Secretary of War.

For further details concerning the operations of the building division, together with costs of various buildings, attention is invited to Appendix D.

#### OPERATION AND MAINTENANCE.

The engineer of maintenance, Lieut. Col. Chester Harding, United States Army, was in charge of the maintenance and operation of the locks and had supervision over the electrical and municipal divisions, meteorology and hydrography, general surveys, and the office engineer. On November 1, 1915, the fortification construction work was transferred to the engineer of maintenance, and on June 1, 1916, the work remaining uncompleted under the terminal construction division was transferred to his charge.

When the change in organization provided by the Panama Canal act was under consideration, I made the recommendation, under date of November 14, 1913, that the engineer of maintenance succeed to the vacancy in the office of Governor of The Panama Canal, thereby assuring a succession which would result in a stable organization. I recommended the assignment of Lieut. Col. Harding for duty with the canal as engineer of maintenance with this idea in view. With the main work completed and the reorganization effected, I requested relief from office effective November 1, and as this was authorized, I requested the assignment of Lieut. Col. Jay J. Morrow, United States Army, for duty with the canal, with the prospect of his becoming engineer of maintenance should the plan originally proposed be carried out. He was assigned to duty as assistant to the engineer of maintenance on August 19, 1915. I submitted my resignation effective November 1, and when enroute to the canal to wind up my affairs I learned of the conditions that had been produced by reason of the slides, in consequence of which I requested the withdrawal of my resignation, and Lieut. Col. Morrow has continued on duty with the canal, performing the duties of engineer of maintenance during the absences of Lieut. Col. Harding and myself from the Isthmus, and at other times rendering important service to the canal on fortification and other work.

Unexpected difficulties developed at the locks, so far as concerns their maintenance, in the protective paints used on the gates and from the electrolytic action in the valves and their various parts.

At the time the locks were watered all the gates had been painted and put in first-class condition. The interiors of the gates were coated with bitumastic enamel under a five-year guarantee, and the exteriors covered with various kinds of submarine paints.

When the floating caisson arrived in December, 1914, it was installed at the lower east lock at Miraflores and the chamber pumped out, permitting an examination of the gates, valves, and fixed irons. At that time they were found to be in good condition, although there was some rusting of the plates and rivets. In January, 1915, the west chamber at Miraflores was pumped out after being submerged about 15 months. The paint on the gates was blistering badly, and from experience gained from various paints applied at other lock gates it was decided that something must be adopted that would give better protection than anything in the paint line that had yet been used. Difficulty had been experienced with paints applied to the spillway gates at Gatun, and because of the condition of the interior of the gates on which bitumastic enamel had been used it was decided to test out the use of this material on one of the spillway gates. It appeared to give adequate protection, and as the contractor guaranteed the effectiveness of his material for five years a contract was entered into for coating all of the lock gates with bitumastic enamel. The gates at Gatun were coated and the work finished. Due to the condition of the pumps in the caisson, the impeller blades of cast iron being entirely eaten away, work on the Pacific side was not completed.

Observations during the past year disclosed that the corrosive action on the cylindrical valves has been severe. In July, 1915, the west flight of Gatun Locks was drained, and all the accessible cylindrical valves were examined. Marked corrosion was taking place on certain parts of the valves, although the entire valve was made of cast iron or steel, no bronze parts being adopted in the original design. In the lower level an average of 75 per cent of the seal segment nuts were corroded; in some cases fully half the nut had disappeared. It was also found that the bolts holding the stops in place were in such condition that they had to be replaced in every valve in the lower level. All valves were put in good condition and painted with red lead. On the Pacific locks no examination was made of the valves at Pedro Miguel or those on the west side of the Miraflores center wall, but the east valves at this site were found to be in good condition; however, as all painted surfaces of the valves had failed, it was decided to coat all exposed iron and steel surfaces with enamel, and a contract was entered into for doing this work.

Considerable corrosion has taken place in the rising stem valves. The half-inch plates have been attacked in a manner similar to those on the lock gates, and portions in the vicinity of the rivets in the lower

valves at Gatun and the upper and lower valves at Miraflores have been violently attacked. The bottom seal casting of the valve which comes in contact with the babbitt metal seal on the bottom of the valve is being rapidly eaten away. A number of the valves at the Pacific locks were in such condition that the bottom seal had to be machined off to make the valve tight. In order to protect the valve from any further electrolytic action between the cast-steel seal and the lower babbitt metal seal, all babbitt metal was removed and replaced with a seal of greenheart lumber. Some of the bronze side seals and springs were found to be broken both at Miraflores and Gatun. Otherwise the seals were in good condition and required only a small amount of draw filing to make the contact surfaces perfect. The top gate valve seal is of cast steel and is held in place by bronze bolts. In practically every instance the corrosion has been excessive around the heads of the bronze bolts, cutting away the metal and in some cases allowing the bolts to loosen and fall out. Several castings had to be replaced. The worst case of corrosion of the seal occurred on the upper valves at Miraflores.

At Gatun practically all valves were installed with fixed side seal castings, which all gave evidence of considerable corrosion, but not sufficient to cause any leaks. At Miraflores removable side seal strips were of machinery steel, and in every case corrosion had reached such a point that all side seals had to be replaced. Inasmuch as the corrosion had apparently been aided by the proximity of the bronze side seals which bear upon them, it was decided to replace all machinery steel with *lignum-vitæ* wood, in this way tending to place an insulating substance in contact with the bronze. All porous concrete around the fixed irons was removed and replaced with cement, and wherever babbitt metal had been used to fill the recessed holes for bolt heads at the Pacific locks the metal was removed and replaced with cement.

At both the Atlantic and Pacific locks considerable corrosion of roller trains has occurred, the rollers of which are made of tool steel. At the Atlantic locks a number of rollers, bolts, and filler castings were missing. All were replaced, and the heads of all bolts were riveted over to prevent further losses. Similar conditions were found at the Pacific locks, and as it is impossible to protect the rollers by any paint, arrangements were made to install one-half inch pipe from the tunnel floors down to the base of the roller-train tracks. Crude oil is forced through the pipes, and it is believed from the results of experiments made with a model that the crude oil will rise along the surface of the roller-train track and in this way protect the rollers by coating them with oil.

As a result of the examination of the valves at Gatun it was decided to have them coated with bitumastic enamel. At the Pacific locks

more complete protective measures were taken, as follows: (1) All bronze side seals were lined up and strips of zinc bolted to the valve each side of the seals at the bottom of the valve; (2) where necessary, the bottom valve seal was machined off to give solid metal contact with the bottom seal; (3) all removable side seal strips were taken out and replaced with *lignum-vitæ* wood strips. Where removable strips were not installed, the fixed irons were milled down to take the wooden side seals; (4) all babbitt metal used in the assembly of the valve for imbedding and protecting boltheads from corrosion and for calking purposes was removed and replaced with cement; (5) all babbitt metal used in the bottom seal was removed and replaced with greenheart lumber; (6) all steel work of the valve was coated with bitumastic enamel. This left only the bronze side seals exposed; (7) all fixed irons were coated with bitumastic enamel; (8) the channel-iron supports for the rollers were coated with bitumastic enamel and arrangements made to lubricate the roller trains and tracks with crude oil during operation and while the valves are submerged; (9) all submerged portions of the valve stems were coated with bitumastic enamel; (10) all bronze bolts are being replaced with steel as fast as breakage occurs.

On October 10, 1915, the counterweight of spillway gate No. 13 at Gatun gave way and dropped into its pit, demolishing all weights. This machine had not been operated for several days, and was not being operated at the time of the accident. On investigation it was found that all four manganese bronze counterweight bolts had given way. Each spillway counterweight consists of 56 cast-iron blocks weighing 750 pounds each, resting on a cast-iron base plate and supported by four  $1\frac{3}{4}$ -inch manganese bronze bolts running into a cast steel yoke at the top. The total weight of the counterweight is 45,700 pounds, and, assuming that the load is equally distributed, each bolt supports 11,425 pounds, or a stress of 4,750 pounds per square inch of metal. Sections of the bolts were sent to the mechanical division for test, which gave an ultimate tensile strength of 61,400 pounds and 63,900 pounds per square inch, respectively, for the two bolts tested. This would indicate a factor of safety of about 13. All guard-valve counterweight bolts were examined and instructions given to replace the defective ones with steel bolts. An examination of the Miraflores spillway counterweight bolts resulted in finding two bolts broken off at the head and others with surface cracks, indicating probable failure. All counterweight bolts of the spillway gate machines have been replaced with steel, and bronze bolts are being replaced with steel wherever failures occur.

On September 4, 1915, the S. S. *Luz Blanca* approached the lower end of Miraflores Locks while the chain fender was up and the semaphore in the danger position. The vessel struck the fender and with-

out appreciably stopping its headway broke the chain. The fact that the machine had been blocked made it impossible for the fender to operate, but, nevertheless, the apparent ease with which the vessel went through the chain called attention to the desirability of a working test to determine the effectiveness of the fenders, and a committee was appointed to make a series of experiments upon one of the chain-fender machines at Gatun. Considerable data were obtained, and the results of the tests indicated that the chain-fender machines will operate satisfactorily when properly adjusted, and that no difficulty would be encountered in stopping any vessel approaching the locks at a speed under two miles per hour. Some minor modifications were made in the apparatus.

Owing to the fact that the slides in Gaillard Cut interfered with the operation of the canal between September 18, 1915, and April 15, 1916, the number of lockages made during the year does not compare favorably with those of the previous year. The number of lockages at Gatun was 2,254, of which 1,779 were commercial lockages for 1,980 vessels; at Pedro Miguel 2,317 lockages, of which 1,825 were commercial lockages for 1,925 vessels; at Miraflores 2,277 lockages, of which 1,842 were commercial lockages for 1,926 vessels. The number of commercial vessels exceeds the number of commercial lockages, due to the fact that whenever possible tandem lockages were made, i. e., two vessels were locked through at the same time. The difference between commercial lockages and all lockages is accounted for by the fact that there is no record given of the number of canal barges, tugs, launches, etc., which were locked through from time to time.

#### ELECTRICAL DIVISION.

This division continued in charge of Capt. William H. Rose, United States Army. The duties of the division comprised the operation of all steam and hydroelectric power plants, the Balboa air compressor; the electrical transmission and distribution systems, and house and street lighting systems; the telephone, telegraph, and automatic railway signal system of the Panama Railroad; the design and construction of all extensions and additions to such systems; and the installation, operation, maintenance, and repair of electrical apparatus of all kinds for other departments and divisions of The Panama Canal.

The hydroelectric station at Gatun, the Miraflores steam-power plant, and the substations, high tension transmission lines and distribution lines were operated satisfactorily during the year. The old steam-generating station at Gatun was dismantled, and the turbo-generators, boilers, and other equipment installed in the Miraflores plant extension, which was constructed for the purpose.

New water wheels of 4,400 h.p. were ordered for the main generating units of the Gatun hydroelectric station, which will result in

increasing the capacity of the station by about 40 per cent. New cable feeders, oil switches, and other auxiliaries for taking care of this increased output have also been ordered, as well as two new 4,000 k.v.a. 44,000 volt transformers for the Gatun substation.

Attention was called last year to the necessity for arranging for increased power, and the appropriations for the coming year provide for an extension to the hydroelectric station by the construction of another building of the same size as the present one, the addition of three new penstocks and one new 4,500 k.w. generator unit. It has been found advisable to change the voltage of the generating station from 2,300 to 6,600 volts to reduce the number and cost of feeder cables between the hydroelectric station and the Gatun substation.

The average production cost of current of the hydroelectric station during the fiscal year was \$0.0006 per k.w. hour, including all operation, maintenance, repair, and division overhead charges, but not including depreciation. Including a charge of 3 per cent of the capital cost of the entire power system for depreciation, the cost of generating power at the hydroelectric station was \$0.0027 per k.w. hour; as distributed from substations, including all charges, the cost of the current for power purposes was \$0.00773 per k.w. hour. The cost for lighting service, including the maintenance of house lighting systems and lamp renewals, was \$0.0145 per k.w. hour.

The cast-iron liner plates and floor plates installed on the baffle piers of the Gatun spillway were in such condition as to necessitate replacement. The concrete behind the iron liner plates was badly rotted away and while thoroughly repaired the action since has been such as to necessitate another overhauling during the next dry season.

On June 30, 1916, 1,878 telephones were in service. During the last six months of the year there was an average of 15,165 telephone calls per day.

A large amount of construction was done by this division on underground conduit lines and underground and overhead distribution lines, as well as in street and yard lighting systems. Motor-driven pumps were installed at Mount Hope Dry Dock. Two hydroelectric graders for the dredging division work on the slides were fitted up; electrical equipment was installed on four berm cranes for the Balboa coaling plant and in the pumping and air compressor plant at Balboa Dry Dock. Lighting and power systems were designed and material purchased for Pier No. 7 at Cristobal and Pier No. 18 at Balboa. Most of the work on the latter pier was completed.

Meters were installed for The Panama Canal and for the Army in 383 houses. Designs and specifications were prepared and material purchased and installed for electrical installation in all new buildings constructed for the canal and for the Army.

## MUNICIPAL ENGINEERING DIVISION.

The organization of the municipal engineering division remained unchanged and continued in charge of Mr. D. E. Wright, as municipal engineer. The municipal division has charge of all water-supply systems on the Canal Zone, including the operation of the water-purification plants.

The water supply for the Isthmus, with the exception of that for the three military posts on the west side of the canal, is furnished by three systems. The water for points north of Gatun, with the exception of Toro Point, is furnished by the Mount Hope plant, which includes the pumping station and the water-purification plant located at Mount Hope. The water is taken from the Brazos Brook Reservoir, supplemented by water obtained from Gatun Lake, at elevation plus 75, through a 20-inch pipe laid in a tunnel 6 feet by 6 feet. The average amount of water handled at this station during the year was 131,232,000 gallons per month.

The water for Gatun and Gatun Locks is furnished by the plant located at Agua Clara, and is obtained from the Agua Clara Reservoir, purified in the filtration plant located near the reservoir and forced by pumps at this station through the distribution system, supplying Gatun and the locks, and also to a 300,000-gallon concrete reservoir located  $1\frac{1}{2}$  miles east of Gatun, which acts as a surge tank. The average amount of water handled at this station during the year was 22,580,000 gallons per month.

The water for Paraiso and all points south, including Panama City, is furnished by the Miraflores plant, which includes the pumping station at Gamboa, Miraflores, and Balboa, and the purification plant at Miraflores, together with the distribution systems and reservoirs. The water is obtained from the Chagres River at Gamboa, and is pumped from there to Miraflores, from which point, after purification, it is supplied to all points south of Paraiso and east of the canal. The total quantity of water handled by this system during the year amounted to an average of 248,963,000 gallons per month.

The municipal division also has charge of the water-supply systems for the troops on the west side of the canal, the water at these points being obtained from the Rio Grande and Comacho Reservoirs, and pumped through the distribution systems to supply the posts. Small pumping plants are also operated at Monte Lirio and Frijoles, to furnish water for the settlements at those points.

The maintenance of the roads, streets, and sidewalks in the Canal Zone, and of the streets in the cities of Panama and Colon, is also a part of the work of the municipal division. The work in the terminal cities is performed for the Panaman Government and the expenses repaid from the water rents collected in these two cities.

A large amount of road-construction work was carried on during the year, particularly in the Southern District in and around Balboa and Ancon. The extension of the Balboa townsite improvements was commenced in March, and was in progress during the rest of the year. This consists of the necessary grading, the construction of streets, and the installation of water and sewer lines in that part of Balboa lying between the existing town and Ancon Hill, to take care of new quarters to be built during the current year. All of the road construction was of Telford base with concrete asphalt surface.

Several important items of construction work were performed by the municipal division for other divisions of The Panama Canal, the Panama Railroad, and the Army, and a part of the work was still in progress at the close of the year. The principal items consisted of water and sewer systems, roads and pavements for the Army posts at Fort Amador and Fort Randolph, and the construction of pavements and grading around the Balboa shops and terminals.

In connection with the water-supply systems of the Zone, Mr. George C. Bunker is employed as physiologist, in charge of the purification plants and the work of the laboratories connected therewith. Notes on the results of his investigations of tropical waters during the past year, carried on by him and under his direction, were set forth in a report, and are of such interest as to warrant their publication. They will be found accompanying the report of the municipal engineer, in Appendix A.

#### METEOROLOGY AND HYDROGRAPHY.

This division continued in charge of Mr. F. D. Willson, chief hydrographer. The tide gauge at Balboa was moved on September 19, 1915, from the old location under the Panama Railroad steel pier to the new concrete dock No. 18. Arrangements were made whereby the weather conditions prevailing over the Caribbean Sea, the Gulf of Mexico, and the South Atlantic Ocean each day at 2 p. m. are received and distributed to the port captains and other shipping interests. At the request of the Argentine Government the daily weather conditions prevailing over the Canal Zone at 8 a. m. are cabled to Buenos Aires.

The rainfall for the calendar year 1915 was above the average at 10 stations and deficient at 8 stations. The average precipitation over the Pacific section was 74.98 inches; over the central section 102.61 inches, and over the Atlantic section 148.60 inches. The maximum 24-hour rainfall recorded during the year was 8.30 inches at Gatun on April 3 and 4. The rainfall during the first six months of 1916 has been above normal over the Pacific section and southern part of the central section, and below normal over the Atlantic section and northern part of the central section.



The average temperature for the year 1915 was near the normal on the Pacific coast, and approximately 1 degree Fahrenheit above the normal on the Atlantic. At Balboa Heights the maximum temperature was 93° F., on April 11, and the minimum, on January 31, 69° F. At Colon the maximum was, on September 27, 91° F., and the minimum on February 10, 72° F.

The wind movement over the Canal Zone for the year 1915 was slightly over the average. Northerly winds prevailed.

No fogs were observed during the year 1915 at the Atlantic coast, but a total of three fogs was observed at the Balboa Heights station near the Pacific coast. Numerous fogs were observed at the interior stations where fog records are kept, and practically all observed lifted or were dissipated by 8.30 a. m.

Fifty-nine seismic tremors were recorded at the Balboa Heights seismological station during the fiscal year. Six of these disturbances were of sufficient intensity to throw the pens from the instruments, and quite a number were strong enough to be generally felt in the Canal Zone. Most of the tremors were of comparatively local origin, less than 600 miles distant. There was an apparent revival of activity in the Los Santos Province that reached the maxima during the latter part of November, 1915, and during the first part of February, 1916. After this time the scene of activity shifted to the northwest, culminating in the tremors of April 26, during one of which considerable damage was done to the wharf and merchandise stocks of the United Fruit Co. at Bocas del Toro. The intensities of the various shocks varied from I to V on the Rossi-Forel scale of I to X.

The yield of the Gatun Lake watershed during the dry season months of 1916, January to April, inclusive, was normal, or an actual yield of 2,200 second-feet against an estimated yield of 2,160 second-feet. It was necessary to waste during January over 2,000,000,000 cubic feet of water, but during February, March, and April the inflow was exceeded by water usage for municipal purposes and evaporation. From January 1 to May 1 the lake was lowered 0.42 of a foot, representing a loss of 1.95 billion cubic feet of storage. The 2,000,000,000 cubic feet of water which were spilled after all the regular demands for water had been met would have been sufficient to provide for approximately 330 lockages in addition to those actually made during the dry season. There were no large freshets during the year 1915, although the yield of the watershed was the largest in the 1911-1915 period, the time Gatun Lake has been an actual body of water.

From a study made of the water supply for the canal it was ascertained that an average of 7.21 million cubic feet of water were used for each through lockage from ocean to ocean; that an average of 12,787.47 million cubic feet of water was wasted over Gatun spill-

way, or a sufficient quantity of water to make 1,773 through lockages each month. Based on 30-day operation this would mean 59 lockages per day over and above the average traffic for the past year. In this connection it may be stated that the maximum number of lockages which can be made in 24 hours is 48, assuming that one vessel leaves the upper flight at Gatun just as another enters the lower chamber, and vice versa, both chambers being used.

### **SURVEYS.**

The surveys were handled by parties under the direction of Mr. O. E. Malsbury, assistant engineer.

The monumenting of the boundary lines between the Canal Zone and the cities of Panama and Colon, in accordance with the treaty proclamation of February 18, 1915, was finished. A regulation concrete monument was set on the Corundu River near bridge No. 65 of the old Panama Railroad; the stone bridge on the Corozal road and the concrete bridge on the Tumba-Muerta trail were stenciled; a brass plug was set in the concrete curb at the junction of the Corral and Tivoli roads, and an iron spike was driven in the center of the Tivoli road at an angle point on the boundary line. For the delimitations at Colon 16 monuments were set on line, and several brass plug reference points were set on the offset line in Folks River. An iron rail was set in concrete at Old Point A, Folks River. Brass bolts were set in the sea walls at both ends of the line. The azimuth line of Colon Harbor was staked out across the fill at the Cristobal fire station. All regular concrete monuments were properly stenciled.

The 100-foot contour survey was finished, with a total of 843 monuments set. Monuments set on the 5-mile line were numbered consistently with the monuments on this line, using the fractions  $\frac{1}{2}$ ,  $\frac{1}{4}$ , etc. The regular 5-mile line type of monument was also used.

This division made a number of surveys throughout the year, in addition to other miscellaneous work.

### **OFFICE ENGINEER.**

The office continued in charge of Mr. C. J. Embree as office engineer, who has charge of the drafting forces of locks operation and maintenance, electrical division, municipal division, division of terminal construction, and building division. A large amount of detail work was done by the office.

For further details concerning the work done under the engineer of maintenance attention is invited to Appendix A.

### **OFFICE OF THE MARINE SUPERINTENDENT.**

The marine superintendent is charged with the entry, conduct of vessels through The Panama Canal, and clearing them after transit,

together with the supervision of the port captains, the board of local inspectors, the pilots, the operation of lights and beacons, and the inspection and admeasuring of vessels.

As already noted, Capt. Hugh Rodman, United States Navy, was detached and succeeded by Commander H. I. Cone, United States Navy, on October 1, 1915.

After trial it was decided, for the best interest of the canal as well as for shipping using it, to have pilots detailed as lock pilots, and two were accordingly sent to each set of locks, acting under the direction of the lock superintendents.

Slides in Gaillard Cut interrupted traffic from August 7 to August 10, 1915, from September 4 to September 9, 1915, and from September 18, 1915, to April 15, 1916.

Punta Mala lighthouse was erected and put into commission on July 10, 1915. Bona Island lighthouse was placed in commission August 2, 1915; on November 25, 1915, it was struck by lightning, but was relighted the following day. The lighthouse on Taboguilla Island was placed in commission August 10, 1915. All three lights proved satisfactory and economical. Some slight changes were made in aids to navigation and in the characteristics of lights, as experience and local conditions seemed to dictate, in order to facilitate the transit of shipping, both by day and night.

A new signal station was erected at Sosa Hill. It commands a splendid view of Balboa Harbor and enables the captain of the port to communicate with ships much more expeditiously than was possible before.

The mooring stations at Gamboa and Empire were maintained throughout the year. The former is permanent; its mooring buoys were renewed and heavier moorings laid. It was found desirable to establish another temporary mooring station near Paraiso. This will probably be maintained until the channel through the slides is in such shape that vessels can safely transit it without delay.

During the part of the fiscal year that the canal was open to traffic a total of 411 vessels passed from the Atlantic to the Pacific, as compared with 530 for the previous fiscal year, and 376 passed from the Pacific to the Atlantic, as compared with 558 during the previous year. The 411 vessels passing from the Atlantic to the Pacific had a total net tonnage of 1,308,230 tons, and 1,434,236 cargo tons. Of this total number of vessels 50 were engaged in United States coastwise trade, with a net tonnage of 183,372 tons and a cargo tonnage of 227,103 tons. The 376 vessels passing from the Pacific to the Atlantic represented a net tonnage of 1,171,531 and a cargo tonnage of 1,705,810. Of this number of vessels 41 were engaged in the coastwise trade with a net tonnage of 167,594 tons and a cargo tonnage of 217,285 tons. The total cargo tonnage that traversed

the canal amounted to 3,140,046 tons, as compared with 4,969,792 for the fiscal year 1915. The total cargo tonnage passing through the canal in the coastwise trade was 444,388 tons for the fiscal year, as compared with 951,044 tons for the previous fiscal year.

While it is to be remembered that the canal was closed for seven months of the fiscal year, this alone does not account for the difference in the coastwise traffic. The lines which formerly used the canal in the coastwise trade took advantage of the scarcity of bottoms and chartered their steamers at enormous rates, which was more profitable than continuing in the coastwise trade.

The board of admeasurers conducted its operations in the same manner as in the previous fiscal year. The requirement that the United States net registered tonnage be considered in the assessment of tolls added greatly to the work of the board, especially because of numerous changes and interpretations placed upon the United States rules for measurement by the Commissioner of Navigation of the United States Department of Commerce. The application of the United States rules for measurement has resulted in exempting practically all sheltered spaces and deck loads of vessels transiting the canal, which, in turn, has resulted in discrimination against most of the United States vessels utilizing the waterway, due to the fact that almost all of the United States vessels are so constructed that they are unable to take advantage of shelter-deck space. On the other hand, the United States rules provide for the exemption of certain cabin space above the upper deck that is not a deck attached to the hull, which would, in most cases, result in discrimination against foreign vessels and in favor of United States passenger steamers, if the national register of the vessel were recognized as a factor in the levying of tolls.

As time goes on and traffic increases, with a resulting increase in the number and classes of vessels using the canal, the necessity of adopting some one rule for levying the tolls becomes more evident, and experience has shown beyond a doubt that the fairest rules for determining the tonnage of a vessel on a just basis are the Panama Canal rules of measurement; in short, on the earning capacity of the ship. It is again recommended that legislation be secured authorizing the levying of tolls on this basis.

The tolls collected amounted to \$2,399,830.42. Had the Panama Canal rules for measurement been in force, the revenue from this source would have been \$2,790,544.47, showing a direct loss of revenue on this account of \$390,714.05.

The captains of the port are directly in charge of the duties of assignment of wharves, docking, and berthing of vessels, furnishing pilot service to shipping, the admeasurement of vessels before transit through the canal, and the general supervision and enforcement of harbor regulations relating to shipping. In addition, an endeavor

has been made to have the offices of the captains of the port centers of information on all matters relating to shipping.

For further particulars attention is invited to Appendix B.

#### DREDGING DIVISION.

The dredging division continued in charge of Mr. W. G. Comber, resident engineer, assisted by Mr. James Macfarlane, superintendent of dredging. The division is divided into two districts, the first embracing all dredging operations in the Pacific entrance, Miraflores Lake, and Gaillard Cut; the second district, all dredging operations in the Atlantic entrance and Gatun Lake to Gamboa Bridge.

As stated in the annual report for 1915, all dredging done in any part of the canal necessary to complete the channel to its full width and depth was charged against construction funds, and all dredging done in portions of the canal where the full width and depth had been secured at the time the canal was opened to the use of commerce became a proper charge against and was paid for from maintenance funds. Consequently, part of the dredging operations constituted construction work and was paid for from such funds.

The dredging equipment in use during the year consisted of sea-going suction dredge *Culebra*; pipe-line dredges Nos. 4, 82, 83, 84, 85, and 86; the 15-yard dipper dredges *Gamboa* and *Paraiso*; the 5-yard dipper dredges *Cardenas*, to September 30, 1915, *Chagres*, to October 31, 1915, and *Mindi*, to November 3, 1915; seagoing ladder dredge *Corozal* and the French ladder dredges Nos. 1 and 5 and *Marmot*; the *Gopher* was in service until August 15, 1915; drill barge *Teredo No. 2*; the rock breaker *Vulcan*; and the 15-yard dipper dredge *Cascadas*. This dredge is an improved model of the dredges *Gamboa* and *Paraiso*, certain changes in design having been suggested by the officials of the dredging division to overcome some of the defects that had developed in the other two dredges of this type, which had been in operation for some time before the *Cascadas* was ordered.

To assist in washing down slides and to arrange drainage through them two hydraulic graders were built, both of which went into commission in December, 1915.

Nine additional dump scows were added to the equipment employed, four of wood and the remainder of steel; of the latter two have a capacity of 3,000 cubic yards each.

The construction dredging consisted of excavating the inner harbor at Balboa, including the dredging around Pier No. 18 and the repair to the wharf, aggregating 1,839,594 cubic yards, at a cost of \$0.1928 per cubic yard; in the vicinity of the Cristobal coaling plant 21,609 cubic yards, at a cost of \$0.3643 per cubic yard; in the vicinity of the east breakwater 353,344 cubic yards, at a cost of \$0.4730; and from the canal prism, Miraflores Lake, 18,602 cubic yards, at a cost

of \$0.2734 per cubic yard; Cucaracha slide, 264,850 cubic yards, at a cost of \$0.3470 per cubic yard, making a total of 4,616,376 cubic yards excavated since the dredging division began work on this slide; at the Pacific entrance, between Miraflores Locks and deep water at sea, 8,964 cubic yards of earth and 39,160 cubic yards of rock at a cost per cubic yard of \$2.26, the high cost being due to drilling and blasting rock areas to be removed later, the latter being broken up by the rock breaker *Vulcan* and by the drill barge; and in the Atlantic entrance 20,746 cubic yards of earth, at a cost of \$0.1323 per cubic yard.

The spoil from Gaillard Cut was disposed of on the dumps located in Gatun Lake from mile 30 to San Pablo, mile 24½; in the Rio Grande Valley south of Cucaracha; Miraflores Lake; at Paraiso, and along the east bank of the canal between Cucaracha slide and Paraiso. There were dumped in Gatun Lake 11,126,625 cubic yards, and in Rio Grande Valley 966,149 cubic yards; in Miraflores Lake 72,214 cubic yards; in swamps around Paraiso 501,615 cubic yards; and in the canal between Cucaracha and Paraiso 1,116,461 cubic yards. The material dumped in the canal was from the ladder and dipper dredges working on the south side of Culebra slide while the canal was blocked, and has been practically all rehandled and removed from the prism.

A large part of the work done by the dredging division was occasioned by the slides, and there was removed a total of 12,695,059 cubic yards, at a cost of \$0.2820 per cubic yard. Of the total amount removed 10,872,509 cubic yards were rock and the balance, 1,822,550 cubic yards, was earth.

Surveys of the canal in the vicinity of the active slides were made daily; the channel was dragged and marked prior to the passage of shipping.

The spirit obtaining in the organization during the construction period was the subject of much commendation, but looking back over the period of my connection with canal work, the spirit that animated the dredging force seems to me to surpass that which existed at any prior period. The dredges were operated 24 hours every day, including Sundays and holidays, for a period of four months, without the least murmur or complaint on the part of anyone in the force, which reflects much credit on the officials of the division as well as on the men comprising it.

The dredging division continued in charge of the production of sand and gravel taken from the Chagres River, for construction purposes, for which purpose pipeline and ladder dredges were employed. Ladder dredge *No. 1* excavated 463,377 cubic yards of run-of-bank gravel, and suction dredge *No. 82* excavated only material to be screened, delivering 48,895 cubic yards of sand, 17,277

cubic yards of No. 1 gravel, and 50,852 cubic yards of No. 2 gravel. All gravel was delivered to the Gamboa handling plant. Sand was passed through a three-eighths-inch screen, No. 1 gravel through a 2-inch screen, and No. 2 gravel through a 2-inch screen.

The old slide at Buena Vista showed signs of new life in December, 1915, and on January 1, 1916, a crack had developed, starting at station 1559 and running over the top of a small hill 300 feet west of the prism line at station 1563 and joining the canal again at station 1567. The material was stiff clay and soft rock. On January 3, 1916, the hydraulic grader began operations, starting at a point about 50 feet back of the crack and cutting a uniform slope from the point of beginning to the base of the slide at the water's edge. This method stopped the movement and the material has remained quiescent during the rest of the year.

The three rock dikes built on the south shore of Limon Bay in 1915, 600, 1,100, and 1,600 feet west of the canal prism, to stop the erosion of the beach at this point, have proved entirely successful. This beach receded between 1905-1911 525 feet, or about 88 feet annually. July, 1911, to June, 1912, the beach receded 75 feet; 1912-13, 110 feet; 1913-14, 48 feet; 1914-15, 40 feet; 1915-16, since the dikes were completed, there has been no change. Only a few thousand yards of silt were deposited in the canal opposite this point during the year, where in past years the silting ran into the hundreds of thousands.

There will be found accompanying the detailed report of the dredging division a statement showing the amount of material removed from the canal prism by the dredges, together with all auxiliary work accomplished by these appliances since the commencement of the canal construction by the Americans in 1904, with a total cost per yard of \$0.2667; also a statement of the work done by steam shovels during the same period, together with the cost.

For further particulars of the operations of the dredging division attention is invited to Appendix E.

#### SLIDES.

Although the question of the slides has been dealt with in previous annual reports and official documents, there continues to exist much ignorance on the subject. Also a great deal has been written by those whose little knowledge makes them dangerous, and to whose statements credence is given because of the position or prominence of the writers. I have concluded, therefore, to report again on the situation, even at the expense of repetition, notwithstanding the general belief that anything published in annual reports is buried in oblivion. Consideration will be given also to the various

theories that have been advanced and to the remedies that have been suggested.

For some unaccountable reason there seems to be a general belief that the entire length of the Cut is affected. A report emanating recently from English sources states that the bottom of the canal through this section is found to be a bog, which is being constantly pushed up, and through which the dredges have difficulty in maintaining a channel; further, that it is acknowledged on the part of those in charge that the canal is a failure, and that American engineers are seeking information in England relative to the Nicaragua route. Such reports are false, and there is no foundation for them; yet they seem to have gained credence probably because a pending treaty between the United States and Nicaragua contemplates securing from the latter all rights for building a canal on its territory. As the Nicaragua route was at one time the one most generally favored by the United States, investigations by commissions, boards, and commercial bodies, covering a series of years, have been made of the route, and data of all kinds collected; consequently everything that is known about that route can be found at home, without the necessity of seeking information in England. It makes a good news item, however; makes converts to the belief that the entire 8.75 miles of the Cut is unstable, liable to collapse or upheaval, completely closing the canal for all time, is useful in assisting shipping companies to take advantage of present conditions to charter ships at excessive rates instead of complying with their obligations, and permits an increase in insurance rates.

Gaillard Cut extends from Pedro Miguel to Gamboa, a distance of 8.75 miles. The canal prism through this section averages 300 feet bottom width, and has a depth of 45 feet. Every foot of the existing channel was excavated through rock, all of which, though of various kinds and densities, had to be drilled and blasted in order to remove it. It is possible that the water may have softened some of the material, yet it is known that the softer varieties of rock encountered in the excavation were protected from disintegration by contact with water. The bog theory is a myth. The Cut has been stable with the exceptions of the portions in the vicinity of Culebra and at Cucaracha. The slides at Culebra are on both sides of the waterway, occupying a length of 2,800 feet, while the channel affected by the Cucaracha slide is less than 2,000 feet long, so that out of a total length of 8.75 miles only 0.88 mile is affected.

Another misconception that exists relates to the character of the slides. They have not been, except in part at Cucaracha, a slipping down of portions of a bank in order to reach the slope at which the material will stand. Slides of this character have occurred, but they were small in extent and easily handled. Those at Culebra



are breaks resulting from deformation or crushing of underlying strata which, under changed conditions, could not bear the weight of the superimposed mass, and caused a vertical settlement or drop of the overlying material, which subsequently moved into the prism. Final rest will be secured when all the material that is in motion has been removed. As is shown by experience with smaller breaks that have occurred from the same cause, when the end is reached the final surface will be concave, or bowl shaped.

When water was turned into the Cut on October 10, 1913, the channel was completed to full width and depth except at Cucaracha, where the steam shovels were making but little headway against the slide; three benches which had been left (one at La Pita Point, one on the east side near Empire, and one on the west side opposite Cucaracha); the inclines, one at either end of the Cut; and the remains of two small slides, one on the east side, of the "break" variety, and the other on the west side, a typical slide of clay which occurred prior to the removal of the steam shovels, both of which, between Empire and Culebra, were cleaned up by the dredges and have remained quiescent since.

Cucaracha slide is on the east side of the canal south of Gold Hill. It began to give trouble as early as 1884, during the operations of the French Canal Co., but all the indications pointed to a surface movement only. The French built an elaborate system of drainage to overcome the difficulty, and, while successful so long as work of excavation was suspended, further deepening of the Cut in the vicinity resulted in renewed activity, with complete destruction of the drainage system; the remaining part of this system was carried away by the slide in 1907. The slide gave trouble in 1906, when excavation proceeded through this section. The difficulties increased as the depth increased and in the autumn of 1907 became most formidable. From this time until 1910 the difficulties became less, and it was believed that they had been overcome and that the clay remaining would be supported by a rock dike which was uncovered and which apparently possessed ample strength to retain the mass above and back of it. On January 20, 1913, the rock dike broke at or below the bottom level of the canal and completely filled the prism with clay and rock for a length of 1,600 feet, to a depth of 30 feet on the bank opposite from the slide, increasing toward the east on a slope of about 1 on 4. Steps were taken, by means of sluicing, to wash back as much of the top portions of the clay as possible into the valley on the east side of the ridge. As steam shovels could not cope with the situation economically and advantageously and as the remainder of the Cut was ready for the admission of water, this was allowed to enter and recourse had to dredges for the removal of the balance. The time within which a passage through the slide was

cut, as well as the cost, is conclusive that this method was the most efficient and economical way of handling the material.

In July, 1914, troubles in Mexico interfered with the handling of cargoes by the Tehautepec route, and shipping interests were clamoring for relief. The dredges had secured a channel through the slide, and the Panama Railroad operated a line of barges through the canal between the terminal ports, but these could not handle the traffic. While the full depth and width had not been secured through the slide, the channel was sufficient for the passage of shipping, and consequently the canal was opened to commerce in August, 1914.

Several movements have occurred since at Cucaracha, but they were handled easily and did not delay commerce until the last of August, 1916, when a movement occurred, bringing down material from the northeast corner of the slide area, and moved huge rock boulders across the center line of the channel, so constricting it as to force a suspension of navigation on August 30, 1916. The largest mass of rock occupied a length of 65 feet. The boulders required drilling and blasting operations in order to remove them. Holes 20 feet deep in a flintlike substance were drilled at great expense of time and drills before they could be broken up sufficiently for the dredges to handle, and the closure of the canal lasted eight days, although two small ships were passed through in the interval.

Gold Hill is of basalt, thrown up in a molten state through the sedimentary deposits that already existed and poured over the deposits on either side of the stem, giving to the vertical section the general shape of a mushroom. The portions projecting beyond the stem, being left unsupported, broke when the material moved from under, and the rock thus detached came down with the rest of the material at Cucaracha. This same action occurred on the opposite side of Gold Hill within a few months after the east Culebra slide became active.

A slide developed during the excavation in 1906 north of Gold Hill on the east side of the Cut. This was a typical slide, a surface movement which flattens the slope, and slides of this character had occurred in this locality during the French occupancy. The French endeavored to overcome them by drainage tunnels, but the material through which they were built was too fine grained to permit the free passage of water, and the method was not continued.

In 1907, at the village of Culebra, the type of slides designated "breaks" first manifested itself. When the excavation had reached a depth of 135 feet above the finished bottom level, a crack appeared in the surface of the undisturbed ground, extending from one point on the prism slope to another. Subsequently there was a subsidence of the surface on the side of the crack farthest from the prism, accom-

panied by an upward movement of a portion of the bottom of the excavated area a little distance from the foot of the slope. This was followed later by a settlement of the mass between the crack and the Cut, which ultimately slid into the prism. The first break affected but a few hundred feet, but as the depth of excavation increased the breaks became more extensive both in length and quantities of material involved; then they occurred on both the east and west banks, the upward movement along the bottom of the excavation continuing until the area affected extended for a length of 2,000 feet north of Gold Hill. The borings of record failed to disclose any weak underlying strata.

The cause undoubtedly was the unequal distribution of the pressure exerted by the adjacent banks. Such being the case, it followed that if the height of these banks were reduced the movement would be lessened, and if reduced sufficiently would cease entirely. Subsequent events proved this to be correct. The banks were lightened by taking material from the top, and there resulted final slopes through this portion of the Cut of 1 on  $1\frac{1}{2}$  to 1 on  $6\frac{1}{2}$  for the east side and from 1 on 2.46 to 1 on 4.35 for the west side; the slopes consisted of a series of steps. The upheaving of the bottom ceased entirely, as already noted, and the canal prism was carried to full depth and width throughout the entire 2,000 feet.

Toward the close of the dry season, in April, 1913, a crack appeared on the east side opposite Culebra, about 1,300 feet from the prism, in an old French dump. It was parallel to the canal, did not join the banks, there was no breaking up of the banks between it and the Cut, nor any subsidence—in short, there were none of the indications that accompanied previous breaks. The geologist believed that it was due to the deformation of the underlying strata and advocated lightening the banks by sluicing and steam shovels, which was done. While this work was in progress the crack gradually closed, and though the surface between the crack and the Cut was in places noticeably below the level of the surface to the east of the crack, the closure was construed to mean that a condition of equilibrium had been reached. The canal through this section was completed, the water was turned in, and no further trouble was anticipated in this section.

A crack had existed for some years at the foot of Zion Hill, southeast of Culebra. The hill was pronounced geologically secure against any movement, and when the material was dug away from the upper portions of this bank, and the slopes of the final bench reached the crack, it did not increase and there was no movement.

Just prior to turning in the water a rock slide occurred north of Gold Hill on the east side, increasing somewhat with the admission of water, causing no change, however, in the crack on the top. A

similar slide occurred on the west side after the prism filled with water. In both instances the movements were typical of the ordinary slides—an adjustment of the slopes. The material was easily handled by the dredges and the channel freed of all obstructions before the canal was opened to navigation. This condition continued until October 14, 1914, when, without any warning, a section of the east bank north of Gold Hill settled vertically 20 feet. This section measured 2,000 feet along the prism face, and extended back about 1,000 feet from the axis of the canal, generally along an irregular curved line, but did not extend back to include the crack that had developed in 1913. The top of the bank was from 300 to 350 feet above sea level. After the settlement the upper surface of the portion that broke away remained practically parallel to its original position, and the existing benches of the upper part of the slide had not changed their relative positions, though they were badly broken up, but the lower strata were squeezed out across the canal, reducing the depth of water from 45 feet to 9 inches at one point within an hour's time. Subsequently the broken mass moved into the Cut, as was the case with other breaks. Navigation was suspended for a week, but after this and until August, 1915, the dredges were able for the most part to keep up with the material as it came down, and would have been able to maintain such condition had not a movement occurred on the west bank, necessitating work on this side to the detriment of the east side.

A crack was found on the slope of Zion Hill in June, 1914, higher up than the crack already mentioned, but observations made upon it showed no movement, and the solidity of the hill was never doubted. Subsequent to the break on the east side, a gradual but general breaking up of the west bank followed. The crack on the slope increased in size and new ones developed farther up the hill, until finally one extended to elevation 480 above sea level, the limit of the present break. The movement into the Cut from the west bank occurred early in August, 1915, when a section of Zion Hill broke away and settled down. The edge of the break on this side is also a curve.

The movements from the two sides were toward the central portion of the inclosed area, and at this central portion the bottom was forced up, at first forming an island, then a peninsula projecting from the east bank, and finally an isthmus entirely across the channel. The barrier increased until it had a length of 255 feet along the axis of the canal and an elevation of 65 feet above the surface of the water. The movements on the two sides are entirely different in character. On the east side a settlement of a mass occurs, the top generally tilting backward from the prism, with a shoving out below. On the west side, for the most part, rock masses become detached and

gradually settle down vertically, with very little lateral movement, pushing out the material along the prism face.

When the break occurred on the east side it was realized that it would extend eventually back to the limiting cracks, and that all the material lying above some surface, concave in shape, unless removed, would eventually enter the prism. It was impossible to handle any of it by hydraulics away from the Cut, and the only other method would be by steam shovels. These could only operate on firm ground, and would necessitate the establishment of dumps. The number of shovels that could be worked would be limited, and considerable excavation would be required before the sliding material could be attacked. The dredges were capable of and were removing over 1,000,000 cubic yards per month without any of the difficulties attending steam-shovel operations, and what could be accomplished by the latter would be relatively so small and the cost so high that the idea of introducing steam shovels was abandoned and the decision reached that the material must be removed from the canal side by the dredges.

From experience with other breaks, it was known that the movement would not be continuous. A settlement occurs, by which material is pushed into the prism; the movement is at first heavy and rapid, gradually diminishes, and finally ceases. This condition of rest is disturbed either by the rains or by the operations of the dredges cutting into the banks. As all the material liable to move must be taken out by the dredges from the Cut, there would come a time when the machines would be idle, waiting for a movement to give additional material for them to handle. The judicious application of hydraulicking the bank would avoid such a condition, consequently pumps for sluicing operations were installed on two barges. These have been used for cutting and maintaining surface drainage and for washing down material to the dredges, when the conditions warranted it.

The finished section from Gold Hill north left an enormous mass of hard rock on the east side and at the northwest corner of Gold Hill. When the break occurred in 1914 this mass of rock was moved slowly into the prism, but finally came to rest and seemed to hold the material back of it, limiting the area of interference in the channel. It stood up boldly for nearly 100 feet and was designated by the working force as "Gibraltar," which designation will be used when referring to this mass of rock.

The slipping of the material into the Cut removed the support to the mushroom portions of Gold Hill on its north side, which broke off in large masses and followed down diagonally toward the prism, the effect being similar to that described as having taken place at

Cucaracha, and the direction of the movement was due, no doubt, to the retaining effect of "Gibraltar," though this took up slow movements at times when the heavier masses back of it were disturbed by subsequent settlements.

If the width of the prism through the slide section remained as fixed for the project—300 feet bottom width—every movement that occurred on either the east or west bank would contract the channel, and should a movement occur in both banks at the same time it would probably result in closing the canal to navigation. The necessity of restoring the channel to permit the passage of ships and the maintenance of navigation were the main considerations. An addition to the width sufficient to take care of material pushed in by subsequent movements, thereby increasing the chances of maintaining a channel, was considered advisable until all the loosened material had been removed. This led to a modification of the projected width, which was increased to 500 feet, 100 feet on either side of the original prism lines.

The conditions as they existed then—in November, 1915—found the canal closed to navigation indefinitely. There was across it an isthmus 250 feet long in the direction of the axis of the canal, the top of which was about 65 feet above water; the dredging operations were confined to the north of this isthmus, working toward the south, with arrangements made for washing down the material in case it was advisable to accelerate the motion of any part of the sliding area, and with the project modified so as to give a completed width north of Gold Hill of 500 feet.

In October, 1915, the President of the United States was advised by a member of the National Academy of Sciences—which was organized by an act of Congress to give expert advice to the President and Congress on scientific matters—who stated that one of its members had made an extensive study of earth slides in tropical countries, and was convinced that there were relatively simple ways by which they could be stopped, and suggested that a committee of mining engineers and geologists of the academy be appointed to consider his propositions. In consequence of this, the President of the United States requested that a committee be appointed by the National Academy of Sciences to "Consider and report upon the possibility of controlling the slides, which are seriously interfering with the use of The Panama Canal." From the correspondence it appears that at a meeting held in New York, "\* \* \* the hope was repeatedly expressed that an effective solution may speedily be found."

The coming of the committee was welcomed on the Isthmus, for so much misinformation had been sent broadcast, doing more injury to the canal than the closing of it by the slides; confidence had been upset; and it was hoped not only that a remedy would be forthcoming

but that the report of the committee would be able to restore confidence in the project, especially as those connected with the work knew that the methods adopted would overcome the difficulties for good and all, given the time and money, and that the waterway would be all that had been expected.

Probably the greatest injury done the canal was through Prof. Benjamin Le Roy Miller, Ph. D., who occupies the chair of geology at Lehigh University. On returning to New York from Costa Rica he stayed here a couple of days awaiting a steamer. He was given every facility to examine the slides at Culebra, which were then at their worst, and he is reported to have said for publication on his arrival in the United States that he had made a "thorough examination of the slides," and the conditions found were as follows—the statement appearing in quotation marks in the press item:

At the Culebra Cut \* \* \* cracks have formed over 1,300 feet back from the canal, and all of the ground intervening is moving toward the Cut. There is no doubt that much rock, now apparently stable, also will move, as its support is withdrawn by the removal of loose earth and rock. Before the canal can be said to be completed and permanently opened to traffic, the amount of material that must be taken out will not fall far short of the amount already taken from the Culebra Cut.

Transportation companies planning to use the canal should realize that they must not expect uninterrupted service for several years. During the dry season the canal may be opened, but it is certain to be closed during the rainy season when the earth is soaked with water and its movement toward the canal facilitated.

In view of the extent of the material that has now started toward the Cut, it seems that steam shovels should again be employed. Practically all of Gold Hill and much of Zion Hill must be removed, and to wait until the earth breaks loose and enters the Cut where the dredges can attack it seems unwise, and unquestionably longer delays the completion of the project. If dredges alone are employed, as at present, the canal may be kept clear during the months when rainfall is lightened, but for many years to come the rainy season is almost certain to cause such slides as to close the canal for weeks or even months.

The "thorough examination" occupied fully three or four hours of his time. The position that he occupied in one of the leading universities of the United States gave credence to his statements, which were copied broadcast, and commented upon editorially to the detriment of the canal. His dire predictions were naturally unsettling to shipping interests, which were guided by them to some extent in routing their commerce elsewhere.

It was anticipated that the committee from the National Academy of Sciences would make a more thorough examination than Prof. Miller had done, and it was hoped that, as a result, the statements of Prof. Benjamin Le Roy Miller, Ph. D., would be found to be what we considered them—erroneous, unwarranted, and unfair, and help restore the confidence that he had helped to destroy.

The preliminary report by the committee of the National Academy of Sciences was submitted to the President in January, 1916. At

that time they expected that their final report would be completed in April, but up to date it has not been received. The preliminary report will be found in Appendix N. It will be noted that the statement made by Prof. Miller, that practically all Gold Hill and much of Zion Hill must be removed, is not concurred in; and in this connection it should be remembered that a committee of this character expresses its opinions guardedly, for whatever happens they must be found on the right side. They advocated, as a matter of scientific interest, the making of an accurate triangulation of the hills in question—Gold, Contractors, Culebra, and Zion—which has been done. By checks made at frequent intervals the slightest movement on the part of any of the four hills would be disclosed at once. No movement of any kind has taken place.

The committee expressed the belief that every available and practicable device for controlling the water, both on the surface and underground should be employed, and to this end advocated covering the slopes with vegetation to prevent surface wash, closing peripheral cracks, draining undisturbed and threatened areas, and draining by tunnels.

For several years the expedient of covering the slopes with vegetation has been carried on, starting under the direction of Dr. Pittier, of the Smithsonian Institution. Where the surface of the ground is in motion, as in the case of active slides, the roots are disturbed, and the steady growth of vegetation is impracticable. Trees and vegetation of all kinds growing on the surface of the ground which broke in October, 1914, were carried down the slide and exercised no deterring effect whatsoever. On sliding ground there is not sufficient time to plant anything and no good would be accomplished. Where the banks consist of the red clay of the country, it is only after considerable difficulty that grass of any kind can be grown on them. Vegetation stops erosion; on this account the work was undertaken and is being carried on.

When peripheral cracks occur in rock with sufficient earth covering they may be effectually closed by the use of a hydraulic grader, as was done in an incipient slide on the west bank of the canal near Las Cascadas. The sluicing down of the earth into a uniform slope not only fills the cracks and prevents the access of surface water into them, but facilitates the drainage by providing a ready means of run-off into the canal. This method, while applied with good results at the north end of the East Culebra slide, so long as the material is at rest, a subsequent movement develops new cracks and irregularities so that until all loose clay and rock is removed and the final slope reached, the relief is temporary only. Where there is very little earth covering, as is the case on Culebra Hill, and where the cracks are wide and extend a great depth in rock, it is not practicable



to close them permanently without expense that is disproportionate to the results obtained.

In compliance with the expressed wishes of the committee while on the Isthmus, subsurface tile drains have been installed within an area on Culcra Hill as an experiment. Also, as suggested by the committee, the fault fissure under the hard Obispo tuff on the north side of Contractors Hill has been sealed and a concrete-lined drain constructed, draining the surface water into the canal, with a view to the protection of the Cucaracha rock beds adjacent to this portion of Contractors Hill.

It is admitted that if the water could be entirely excluded the earth movements would cease, but unfortunately this is impossible. With the heavy tropical downpours the best that can be done is by drainage, to carry away what falls as rapidly as possible, but ground water can not be eliminated. So far as concerns ground water, the construction of the canal has created entirely new conditions. The old tributaries of the Chagres River and those of the Rio Grande, which formerly were natural drains, are now well above the water surface of the canal, and the canal has become the drainage channel for the country for miles on either side. Even assuming that were it possible to devise a system for getting rid of ground water, it must still exist below the surface of the water in the canal itself. The slides in question affect the banks for a considerable distance down, probably below the bottom of the canal, and if ground water be primarily the cause, then it can not be removed from the strata at which the trouble starts.

Surface drainage was maintained throughout the period of dry excavation. The adjacent country on either side of the canal was drained through the east and west diversions, which continued to act as drains, discharging their accumulated waters into the Chagres. In relieving the pressure, force pumps on barges have enabled the washing down of part of the material, as already explained. The hydraulic grader which was constructed in July, 1914, and put in commission in August, 1914, was built especially for opening channels to expedite surface drainage at various points along the line of the canal, and to maintain them, and this work has been carried on, although suspended south of the slide, due to the interruption and shut-off of the channel last fall and winter.

So long as the slides are active and the configurations of their surfaces change as rapidly as they now do, it is impracticable to open and maintain the permanent drains recommended in the moving areas. When equilibrium is restored, and as a means of promoting permanent stability, the drains of a permanent character should be constructed and maintained.

Drainage by tunnels has been considered in connection with data obtained since the committee's report was written, as the result of experiments suggested by the chairman of the committee, Dr. Van Hise, through whom the services of Prof. Warren J. Mead, of the University of Wisconsin, were secured, and who was assisted by Mr. Donald F. MacDonald in making tests of the rock formation in which the east and west Culebra and Cucaracha slides have occurred. I have received from Mr. MacDonald, the geologist, a brief report, hereto appended, marked "Appendix O," which states the result of the experiments, as follows:

Twenty-one average samples of the Cucaracha or sliding formation were taken from below the water level of the canal. These samples, completely saturated, contained 12.20 per cent of water by weight, or 27.8 per cent by volume. The 16 average samples taken from well above the level of ground water, where the rocks were much jointed and fractured and, therefore, perfectly drained, contained 10.60 per cent of water by weight. As shown above, 12.2 per cent of water by weight fills all of the pore spaces of the rock; therefore, 10.6 per cent by weight fills only 87 per cent of them, leaving 13 per cent of the total pore space as having been emptied by drainage and by drying. Now, 13 per cent of 27.8 per cent is 3.6 per cent of the total volume of the rock. This shows that natural drainage of the most perfect kind would not remove more than 13 per cent of the water by weight, equivalent to 3.6 per cent of the volume of the rock. However, most of the samples from the drained rock were taken very close to the surface, so that very likely they lost some of their water through drying out by the heat of the sun, for the dry season was more than a month old at the time they were collected.

These facts show that while the sliding rocks have a high percentage of pore space, the pores are mostly of capillary size and are filled with water which obeys the laws of capillarity and which can not, therefore, be drained off. These experiments definitely established that all cures by drainage which had been offered to and urged on the canal authorities were absolutely futile, and the money which might have been wasted in worthless tunnels, wells, and acres of asphalt covering, was saved for the only remedy that could bring permanent cure under the circumstances—dredging.

Before considering the suggestions that have been made for controlling or preventing the slides other than those already mentioned, it may be well to state what was attempted by the canal forces in this direction prior to the occurrence of the slides which are now active.

During the excavation of the Cut 22 slides and breaks of various extent occurred. The steps taken to protect exposed slopes by vegetation has been noted. It was believed that piles driven through the loose material into firm ground below and tied at the tops might check the movement, and this was tried at four of the slides, but without success. In some instances the piles were carried bodily down the slope; in others the underlying material, moving faster than the upper portion, inclined the piles away from the Cut, and in cases where the top surface moved faster than at the bottom, they inclined in the opposite direction. The remains of these piles can be seen at the present time in some of the areas so treated.

It was thought that in case of clay slides heavy riprap dumped on the surface would find its way through the loosened material to firm ground and check the movement, but this method was found as useless as the piling. Most of the riprap rock was taken out at the foot of the slope as the excavation proceeded. Experiments were made by concreting the face of the prism to prevent the disintegrating effect of the air on some of the softer rocks; this was done by use of a cement gun, by plastering the surface with cement mortar and by reinforced concrete, anchored to the side of the prism with pieces of rail. None of these methods was satisfactory or durable. The remnants of the French drains, which proved inadequate, were dug out at the bottom of the prism. The conclusion was reached that the only cure was the removal of all loosened material as it came into the Cut, and in case of breaks to relieve the weight, where possible, from the upper parts of the banks by steam shovels or sluicing operations.

In considering any method for stopping the slides some conception must be had of the enormous amount of material involved, as well as the method in which it acts. The banks at present giving trouble are from 300 feet to approximately 550 feet above sea level, and extend back 1,300 to 1,800 feet from the faces of the prism, and from these farthest points to the water surface the entire mass is broken for a depth extending at least to the bottom of the canal. As already explained, the movement is by fits and starts, sudden at first and gradually subsiding, with renewed activity after a period of quiescence. For instance, in August, 1916 a general movement occurred at the east Culebra slide and consisted of a settlement from 20 to 25 feet vertically down at the rear portion of the area affected, some 1,300 feet from the prism, by which a mass of material from the lower part was projected into the Cut beyond the center line, reducing the depth of water along this line an average of 5 feet. Because of the width of the new channel, as well as the depth, navigation was not interrupted, but some idea may be had of the enormous amount of material that must be held back by any artificial construction or device similar to those which have been proposed, and the impossibility of their construction must be recognized.

Suggestions most frequently made have been along the line of sowing vegetation and of properly draining the area. These have already been considered. To sink a number of pipes and apply steam for drying out the subsoil would be prohibitive on the score of expense, even if it were practicable. It would be impossible to drive and hold such pipes through the material in case of motion. Pipes sunk for the purpose of pumping out the water are equally impracticable and impossible. From the experiments conducted by Prof. Warren J. Mead and Mr. MacDonald all the water could not be extracted by this method. Piling the entire area at regular intervals

and tying the piles to anchors driven in the firm ground can not be done, nor would it secure the result anticipated by the proposers of this scheme.

The construction of retaining walls would require the excavation of material to secure the foundations, necessitating the removal of all the material in motion, when the need for the retaining wall would no longer exist. There is no form of construction that could be designed that would hold back the superimposed mass while the excavation for the foundations was in progress. The construction of inverts to hold down the bottom of the prism is impracticable and impossible.

Wire netting rolled over the bank and held in place by stakes would not prevent the movement, but would seriously interfere with the dredges in removing the material littered up with sections of wire mesh, which would break loose with every movement of the slide. Consolidating the mass by injecting grout would also be impossible; the pipes could not be driven to firm ground below and the earth and rock, as it now comes into the Cut, can be much more easily handled than would be the case were this material solidified by cement.

It was suggested that the slopes and the surface of the ground adjacent to the Cut be covered with asphalt, tar, or some preparation which would exclude water from the ground. This was also proposed by a member of the committee from the National Academy of Sciences. That the committee did not include it among its recommendations seems conclusive that in its opinion it was not practicable, and no further comment seems necessary.

A number of theories have been advanced as to the cause of the difficulties, among them that there exists a huge reservoir of water within the earth and the pressure therefrom produces the slides. If this be so, the pressure being sufficient to break the ground would release the water and allow its escape. All the water that is drained from the slide areas is accounted for by the rainfall and by the escape of any ground water that the movement might liberate, and the theory is untenable. The mutual attraction of the large masses on either side of the Cut is assigned as the cause for bringing down the material, and yet another that a huge magnet that previously existed has been cut in two.

The latest theory advanced appears in an article published in the New York Sun on June 18, 1916, by the Hon. Thomas Kearns, ex United States Senator from Utah, and republished as Senate Document No. 525, Sixty-fourth Congress, first session.

He believes, " \* \* \* that the trouble is all caused by subterranean gases formed in the earth which, when permitted to escape through certain channels or breaks in the earth, carry with them

eruptive material, sometimes for a long distance, to the place of the least resistance." Coming from a man with such large practical experience, it undoubtedly carried conviction to the minds of many who read it. Since Senator Kearns's examination was more thorough than that made by Prof. Benjamin Le Roy Miller, Ph. D., it is comforting to note from his judgment also that Gold and Contractors Hills are not likely to fall into the Cut.

Senator Kearns is in error when he states, "Since it (the canal) was first opened to navigation on August 14, 1914, it has been closed and out of commission virtually two-thirds of the time." The canal was opened to traffic August 15, 1914, and up to June 18, the date of the article, the canal was closed 232 days out of 656 days, or approximately one-third of the time, instead of two-thirds, as stated.

Another error is that there was an upheaval in the bottom of the Cut at some other point than the Culebra section. At no portion of the canal has there been any upheaving except in the 2,000 feet north of Gold Hill. This upward movement first occurred when the excavation had reached elevation 175 feet above sea level, or 135 feet above the finished bottom of the canal. The upheaval, as the result of the present slides, reached an elevation of 65 feet above the water surface, or 110 feet above the bottom of the canal. In no case was there a movement at the bottom that was not preceded by a movement in the adjacent bank. The movement in the bottom ceased entirely in 1913, when the side slopes were made sufficiently flat to reduce the pressure exerted by them to less than that required to accomplish this upward movement. The upheaving in the bottom occurred again subsequent to the break in October, 1914, when the huge masses of the banks crowded toward the axis of the canal and disturbed the condition of pressure that existed prior to the occurrence of the slides. Part of the shoaling in the canal is undoubtedly due to the resistance to the motion of the mass at some part of the bottom, which throws part of the slide itself upward with the effect shown.

According to Senator Kearns's theory, gases forming somewhere in the interior of the earth in escaping carry with them eruptive material to the place of least resistance, or in this instance through the bottom of the canal. The breaks, which produced fissures several hundred feet deep, liberated no gas. With a pressure sufficient to accomplish such destruction of the structural formation of the rocks, apparently the gases returned to their storage to attempt later a forced passage through the bottom. We unconsciously endeavored to assist their efforts by digging away 110 feet of their container, but even this did not induce the gases to come forth; thus far there has been no evidence of escape anywhere along the line of the canal, nor has there been any upheaving movement anywhere except in the Culebra district, where the slides occur. So long as there is no movement in

the banks we are able to reach bottom grade and keep it. Under the circumstances, those on the work still adhere to their belief that subterranean gases have nothing whatever to do with the movements that have occurred.

The methods proposed for securing a channel through the slides and to maintain it, adopted in October, 1915, were laid before the committee of the National Academy of Sciences, including the sluicing operations proposed on the west side, but no suggestions were made which modified the plan in any way. The various propositions made by a number of people seeking to help us in our troubles were carefully considered, as were also the theories advanced setting forth the probable causes. There were a number of letters, the writers proposing, for suitable monetary consideration, to cure the slides, but these were filed. None of the suggestions or theories tended in any way to change the plans adopted.

The dredges did their work so well that a channel was cut through the Isthmus connecting the two banks, of sufficient size to pass the small ships still tied up and awaiting transit. By April 15, 1916, a sufficiently stable channel had been secured to warrant opening the canal to navigation, and the transit of shipping has continued to date. Except at "Gibraltar" the waterway is 500 feet wide with 40-foot depth over the greater part, this depending on the movements that occur in the banks. So far as the Culebra slides are concerned, the worst is over; the intervals between movements are becoming greater and the quantities of material less; the only danger being at "Gibraltar," but it is hoped that the excavation continued along the lines contemplated will enable the widening of this section to the adopted prism line without interfering in any way with the transit of shipping. The reopening of the canal was at the beginning of the rainy season, and thus far the rainfall has been above the normal.

The recent movement at Cucaracha was, as usual, the unexpected, coming as it did from the high ground in the northeast corner of the slide area. The difficulty attending this was not a question of amount of material, for the dredges could cope easily with the movement on this score; the hard flinty rock was difficult to break up, and caused irritating and aggravating delays.

As predicted at the time the great Culebra movements occurred, the slides will be overcome finally and for all time, notwithstanding the calamity howlers and in spite of the disastrous predictions of the "know-it-alls."

#### MECHANICAL DIVISION.

The mechanical division continued in charge of Naval Constructor D. C. Nutting, United States Navy. The establishments in operation under this division consisted of the Balboa shops, including car shop and roundhouse; the Paraiso shops; the Cristobal dry-dock

shops; the Cristobal roundhouse, and car shop; and the car inspection forces at Balboa and Mount Hope.

The amount of work on the dredging equipment and vessels using the canal was sufficient to permit organizing the forces at Paraiso and the dry-dock shops at Cristobal on a marine basis. The marine work at Balboa increased materially. It was anticipated that the Paraiso shops would not be operated during the past fiscal year, but due to the slides in Gaillard Cut it developed that these shops performed more work than at any time since their establishment.

At the end of the year the capstans and the traveling crane for Dry Dock No. 1 had not been delivered, and the official test of the dock pumps had not been begun. It was possible, however, on June 28, to dock the seagoing ladder dredge *Corozal* and to remove the water from the dock with the main pumps.

Delay in the completion of building No. 29 for covering the air-compressor plant and dock pumps prevented starting the new electric-driven air-compressor plant until April and kept the old Balboa plant in service under the electrical division. Three electrically driven air-compressor units were purchased for installation in building No. 29, but in view of the delay in their installation and the bad condition of the air compressors at Cristobal dry-dock shops, it seemed desirable to divert one of them to Cristobal. As purchased, there were two units of 2,500 feet capacity and one of 5,000 feet capacity. One of the former was installed at Cristobal. It is now found that the three machines intended for use at Balboa will probably be insufficient to supply all demands, and it is intended to add another 5,000-foot unit, thus making the total capacity 12,500 cubic feet per minute instead of 10,000 cubic feet, as originally designed.

Provision for car-shop work at Balboa proved inadequate during the rush of railroad transportation incident to the closing of the canal in September, 1915, necessitating the opening of the old car shops at Cristobal for work on box cars and Roger ballast cars. These shops were closed on July 29, 1916, and the work transferred back to Balboa, where conditions had improved so as to permit its being handled there.

The purchase of new tools and the increase in the amount of marine work will necessitate alterations and additions to some of the shop buildings at the Balboa shops.

At Paraiso a considerable increase in the machinery of the plant was made; an extension was built to the blacksmith shop for housing the flange fires and an additional steam hammer, and oil fuel was provided for its operation. The tool room was extended into the space previously used as a shops' office, and the space formerly used as an air-compressor plant was converted into an office for foremen. With the increase of work, the three 550-foot motor-driven air compressors

proved inadequate to supply compressed air, and one of the Babcock & Wilcox boilers formerly in use at the Gold Hill sluicing plant was erected and connected to a 2,500-foot air compressor from the old Empire air-compressor plant; the pumps for water service under the municipal engineering division were supplied with steam from the same boiler, thus permitting one force to handle both the air compressor and the pumps.

At the dry-dock shops, Cristobal, very little work incident to improvement of the plant was done, with the exception of installing the new electric-driven air-compressor and electric motors for operating the dry-dock pumps.

All heavy repairs to locomotives were made at the Balboa shops and covered general overhauling of 14 engines, besides those being repaired and packed for shipment to the Alaskan Engineering Commission; 4 were completed for the latter purpose, and 4 are now under repairs with the expectation that they will be shipped so as to arrive in Alaska before the close of the season for navigation.

Extensive repairs were made to the launch *Birdena*, the tug *De Lesseps*, launch No. 26, and the tugs *Reliance* and *Bolivar*.

The floating cranes *Ajax* and *Hercules* were transferred from the mechanical division to the dredging division in October, 1915.

The fuel-oil pumping plants were operated by the mechanical division until September 1, 1915, when they were turned over to the supply department. Two additional 55,000-barrel fuel-oil tanks were purchased and at the close of the fiscal year one at Balboa was ready for service, while the foundations had been prepared for the one at Mount Hope and the work of its erection had begun. Two 5,000-barrel gasoline tanks—one at Balboa and one at Mount Hope—were erected and connected. A 500-barrel tank was also erected at Balboa with connection to a standpipe for filling tank cars on the tracks of the Panama Electric Co. for transporting fuel oil to their plant in Panama.

The necessity for using air drills on the banks abreast the slides required considerable compressed air immediately adjacent to the work. This was obtained by installing two 2,500-foot air compressors, from the old Empire air-compressor plant, on board the seagoing suction dredge *Caribbean*, operated by steam furnished by the boilers of the vessel. Later it was decided to convert the *Caribbean* into a cattle boat for transporting native cattle from Colombia for the commissaries, and compressed air was then supplied by two of the Babcock & Wilcox boilers previously in use at the Gold Hill sluicing plant, installed on the deck of an old rock barge, together with a 2,500-foot compressor installed at either end.

Vessels were docked during the year at the Cristobal dry dock as follows—67 for the dredging division, 3 for the marine division, 10 for



the Panama Railroad, 5 for the Army, 8 for the Navy, 4 for individuals and companies, 7 for the east breakwater, and 2 for the Panaman Government.

Work done for individuals and companies included extensive repairs to the boilers of the steamships *Whitgift* and *St. Louis*, to the rudder of the *Curaca* and to the stern of the *Elm Branch*. Three manufacturing orders of considerable magnitude were accomplished for the Ferrocarril de Arica a La Paz, consisting of six cast-steel frames for geared mountain climbing locomotives, 3,000 semisteel rail chairs, and 16 steel gears for use on locomotives.

For further details, and a statement of the amount of work done during the year by the various shops, attention is invited to Appendix F.

#### SUPPLY DEPARTMENT.

The supply department has charge of the storage and distribution of materials and supplies for use of The Panama Canal and its employees; for other departments of the United States on the Isthmus and their employees; for vessels of the United States, and for other vessels when desired by them. It operates commissaries, hotels, and messes; has charge of the maintenance of buildings and the assignment of quarters and care of grounds. It recruits and distributes unskilled labor and is in charge of all animal transportation. The department continued in charge of Maj. W. R. Grove, United States Army.

The labor force remained practically intact during the greater part of the year, because of the terminal construction and the dredging in Gaillard Cut. In May, due to the near completion of the dry dock and coaling stations, the force was reduced, the force report showing a total of 23,462 employed on June 30, 1916, as compared with 26,897 employed on June 30, 1915, or a net reduction of 3,435. There was a surplus of labor throughout the year in all grades. The repatriation of those for whom it was impossible to find work was continued, and 1,661 took advantage of it, at a cost to the canal of \$33,919.65. No contract laborers were recruited.

*Quarters.*—The village of Corozal was abandoned effective December 1, 1915, and the houses occupied by canal employees turned over to the Army. The transfer of the gold employees and their families to the Ancon-Balboa district resulted in a congestion in this district, the number of applications on file for quarters increasing to 379 on June 30, 1916, as compared with 274 on June 30, 1915. On June 30, 1916, there were 850 applications for family quarters on file, including 114 for families occupying regular or nonhousekeeping family quarters at stations other than those at which applications were filed.

Additional quarters were completed and occupied as follows:

Fifteen 4-family, seven 2-family, twelve 1-family, all frame; two 2-family, ten 4-family, concrete; one special bachelor apartment, of concrete; one special bachelor apartment, frame.

*Corrals.*—There was no decrease in the demand for wagon transportation, all animals being worked to their full capacity. Due to improved road conditions, particularly on the Pacific terminal, motor trucks were substituted for animal-drawn wagons, both for delivery service and trucking. Animals dying or destroyed during the year amounted to 37; animals surveyed and sold, 3; and animals in corrals at the close of the fiscal year totaled 519—horses 118, mules 390, and ponies 11.

*Material and supplies.*—A total of 1,776 requisitions were prepared and forwarded to the general purchasing officer, as compared with 1,428 during the previous year. The total value of material received was \$9,945,390.32, as compared with \$8,018,418.03 for the previous year, the increase being largely due to the increased prices of material. The local purchases amounted to \$1,569,812.15, as compared with \$1,360,469.71 for the previous fiscal year.

There was a general increase in the price of many of the staple articles of material, especially iron and steel; the average price of steel and iron on hand June 30, 1915, was \$1.63 per cwt., as compared with \$2.17 per cwt. on June 30, 1916.

All storehouse operations were placed under the supervision of a general storekeeper, comprising the storehouses at Balboa, Paraiso, the obsolete stores at Mount Hope and at the dry dock, Cristobal. On June 30, 1916, the value of material in stock was \$4,198,392.34, as against \$2,925,332.91 on June 30, 1915, not including the stock of obsolete and retired material and equipment on hand at the Mount Hope store. The increase in the value of the stock material was due, in large measure, to an increase in the purchase price of a large number of items. The consumption of cement amounted to 567,024 barrels.

*Scrap.*—The policy of concentrating at the obsolete storehouse at Mount Hope all surplus, obsolete, and scrap material and equipment was continued. The sales of this material continued to be made, under authority of the sundry civil act of March 3, 1915, and the Executive order of May 12, 1915.

The American scrap operations at the obsolete store show on hand 48,909 net tons, of which 21,249 were received during the year. There were shipped to the United States 10,156 net tons, and issued locally 5,969 net tons, or a total of 16,125, leaving on hand 32,784 net tons. Under advertisements contracts were made for the sale of 9,210 net tons of miscellaneous scrap to the Federal Iron & Steel Co., of Newark, N. J., for \$31,767.56, and 6,000 gross tons of scrap

rail to the David Kaufman & Sons Co., Elizabethport, N. J., for \$48,280. Under a later circular, 13,310 net tons of miscellaneous scrap were sold to the Federal Iron & Steel Co. for \$78,333.98, 890 net tons of miscellaneous scrap to the David Kaufman & Sons Co. for \$4,147.20; and 810 net tons to N. Samuels & Sons Co., of New York, for \$3,936.50. All of the material sold under the first circular was paid for in full by the purchasers, but a large part of it remains on the Isthmus. About 890 tons of material under the second circular has been paid for, but not removed from the Isthmus. The contractors are paying storage on all the material sold but not yet removed.

Material to the value of \$220,116.40 was sold from the storehouses to the United States Army organization stationed on the Isthmus. The principal items consisted of forage, lumber, building material, and general hardware. There was an increase in value of supplies sold to steamships in transit through the canal and those touching at the two terminals. The value of supplies sold was \$70,918.22, representing miscellaneous ship supplies for 860 steamers.

Surplus and obsolete material with an appraised valuation of \$222,735.24 was forwarded to the United States for sale. Local credit and cash sales of obsolete material and equipment amounted to \$205,473.94, and obsolete material to the value of \$292,994.89 was issued and transferred from the obsolete store to divisions of the canal. There was on hand on June 30, 1916, surplus and obsolete material with an appraised value of \$665,396.40.

*Fuel-oil plants and storage.*—The supply department took over the construction of the Balboa and Mount Hope fuel-oil plants on September 1, 1915. The Panama Canal received during the year 676,497 barrels, of which 579,389 were stored in its tanks at Balboa and the balance, 97,108 barrels, at Mount Hope. Of the amount stored, 517,191 barrels were drawn from Balboa and 108,746 from Mount Hope for use by The Panama Canal. To outside parties 48,427 barrels were sold from Balboa, and 12,093 barrels from Mount Hope. Oil handled for individuals and companies through the oil pumping plants aggregated 893,165 barrels, and the total amount of fuel oil handled through the Balboa and Mount Hope oil plants was 2,256,119 barrels.

*Gasoline.*—A new storage tank, with a capacity of 200,000 gallons, was completed September 9 at Balboa, and the first cargo of bulk gasoline of 102,476 gallons was received February 18, 1916. An additional cargo of 100,550 gallons was received March 26, 1916, and emptied into tank No. 31. The installation of the "Martini Hueneker" system for protecting gasoline in storage against accidental ignition of its contents was completed at storage tank No. 31 on June 28. This system provides and maintains a blanket of inert noninflammable gas in

the tank above the surface of the gasoline. Storage tank No. 27 at Mount Hope, with a capacity of 200,000 gallons, was completed December 15, 1915. Up to the end of the year it had not been considered necessary to order a supply of gasoline for the Atlantic side. The total amount sold to outside parties was 199,280 gallons, and used by The Panama Canal 362,371 gallons.

*Subsistence.*—The supply department continued the operation of the Washington, Tivoli, and Aspinwall Hotels, also the line restaurants and laborers' messes. The Hotel Washington is owned by the Panama Railroad Company and the remainder by The Panama Canal. The revenues of the Tivoli and Washington showed an increase over the previous year of \$33,310.26.

The Tivoli Hotel showed a net profit of \$24,929.85, compared with a loss of \$1,974.16 for last year. Had a charge been made for building repairs a net profit of \$17,007.51 would have been shown. While some of this increase may be due to the tourist traffic, the larger part is due to the interest of American business men in Panama and South America. It is believed that this element of the business will increase and that there will be a demand on the hotel facilities in the future for accommodations for representatives of American business enterprises.

The existing structure (frame) is badly ant-eaten and rotted, so that extensive repairs will have to be made or a new building constructed, and I am including in the estimates for the next fiscal year the sum necessary for building a new structure of reinforced concrete.

The experiment with the Hotel Aspinwall at Taboga was continued, but employees availed themselves of the opportunity so little that on July 1, 1916, the hotel was closed, the loss amounting to \$4,554.09. The hotel at Corozal was closed when the village was vacated and turned over to the Army.

The net revenue for the year from restaurants and messes was \$661,017.90, while the total cost of operations was \$648,565.39, resulting in a profit of \$12,452.51. Had the charges for building repairs, fuel, light, etc., been made, there would have been a net loss of \$3,727.68. No charge for equipment has been made, but is absorbed by allotments from appropriations.

Congress appropriated money for rebuilding the restaurants, substituting concrete and tile construction with equipment of glass and metal from the old frame structures. This will enable the hotels to be kept vermin-proof and thoroughly sanitary. The caf  teria system has so completely met the conditions on the Canal Zone that it will be extended to the Ancon restaurant, which has been maintained heretofore solely on the    la carte basis.

*Mount Hope printing plant.*—The value of the stock on hand at the close of the year was \$53,407.02, as against \$45,198.38 for the pre-

ceding year. To the equipment were added five Chandler & Price platen presses with motors for operating, and various other small items, at a total cost of \$1,960.30. The value of the equipment on hand is \$37,897.57.

The commissaries of the Panama Railroad were operated by the supply department. On account of the high cost of beef purchased in the United States the purchase of local cattle was continued, ranges provided for fattening, and an abattoir constructed. During the year the abattoir was enlarged and a fattening house constructed, which is being operated in connection with it. A total of 7,762 cattle were killed and 3,843,377 pounds of dressed beef turned out, the value of which amounted to \$446,682.69.

For further details attention is invited to Appendix G.

#### ACCOUNTING DEPARTMENT.

The organization of the department was unchanged during the year. Mr. H. A. A. Smith, as auditor, continued at the head of the department, and immediately in charge of the division of auditing and accounting, Mr. John H. McLean, as paymaster, and Mr. T. L. Clear, as collector. The office of the department in the Washington office was under Judge B. F. Harrah, as assistant auditor, with Mr. Virgil C. Miller, as disbursing clerk.

The paymaster disbursed \$26,933,528.35, of which \$8,694,110.12 was on account of the Panama Railroad Company. Collections made on pay-rolls, mainly on account of coupon books and meal tickets, amounted to \$2,709,743.60. Of this amount \$2,556,093.08 were disbursed directly by the paymaster, and the balance transferred to the collector's account. The Commercial National Bank of Washington, D. C., established a branch on the Isthmus, which was made a Government depository as well as a fiscal agent.

Collections made and repaid to appropriations amounted to \$7,220,622.65. The sum of \$2,756,764.83 was collected and deposited as miscellaneous receipts. Under the provisions of section 3 of the sundry civil act of March 3, 1915, the Comptroller of the Treasury has detailed employees, one from the office of the auditor, War Department, and the other from the office of the Comptroller of the Treasury, to make the required semiannual examination of the collection accounts on the Isthmus.

A number of small claims for damages to vessels passing through the locks were made, in accordance with the provision of section 5 of the Panama Canal act, and \$1,578.65 were paid in settlement of 13 claims.

Appropriations by Congress for the canal and the fortifications thereof aggregated \$415,985,149.02, including the appropriations

made July 1, 1916. Of this amount \$19,224,873.30 were for fortifications; \$1,000,000 to cover the four annual payments of \$250,000 each to the Republic of Panama, and \$6,000 for the expense of presenting the steam launch *Louise* to the French Government. In addition, \$7,050,000 were appropriated for operation and maintenance, sanitation, and civil government for the fiscal year 1917, and \$6,440,000 for the fiscal year 1916, while \$4,289,159 were charged against the operation and maintenance of the canal for the year ending June 30, 1915. Of the stock of material and supplies on hand \$2,225,000 will be used and charged against the operation and maintenance of the canal. Three million four hundred thousand dollars were appropriated for colliers, \$800,000 for Dock No. 6, Cristobal, and \$600,000 for new boilers in the steamships *Ancon* and *Cristobal*, which, deducted from the total sum appropriated, leaves \$370,950,116.72, or a balance of \$4,250,783.28 available for appropriation within the limit of cost of the canal and the authorized bond issue.

Up to June 30, 1916, the miscellaneous receipts covered into the Treasury, exclusive of tolls and Canal Zone revenues, amounted to \$6,832,144.14, so that the cost of the canal to date, so far as construction is concerned, amounts to \$364,117,972.58. This takes no account of receipts from future sales of construction material and equipment, payments to be made by the Republic of Panama for the sums expended on account of waterworks, sewers, and pavements in the terminal cities, and the equipment transferred to the Alaskan Engineering Commission and the State Department. The estimated value of the items so transferred aggregated \$7,155,978.80. In addition to the construction of the canal, covered by the estimates on which the bond issue was authorized, a dry dock, two coaling stations, terminal piers, and wharves have been built, as well as a new hospital at Colon and new building for the *Ancon* Hospital, none of which was contemplated. Furthermore, injury claims amounting to more than \$1,000,000 were paid, and not provided for in the estimates of 1908.

Under the agreement with the Republic of Panama, which requires the reimbursement to the United States for expenditures for waterworks, sewers, and pavements in the terminal cities, the expenditures to June 30, 1916, totaled \$3,853,576.15. The United States has been reimbursed, or is immediately due \$1,789,895.11, leaving a balance of \$2,063,681.04 payable in installments during the next 44 years for work done in the two cities.

There were expended in construction work \$8,844,125.26, the principal items of which were the east breakwater at Colon, \$1,238,611.68; dredging from Gatun to Pedro Miguel, \$104,738.79; aids to navigation, \$43,828.20, including Punta Mala light \$19,048.63, Bona Island light \$2,974.52, Taboguilla light \$3,601.76, mooring station at Paraiso \$3,519.30, and Sosa Hill station \$5,214.56. For the Atlantic

terminal \$1,551,747.62 were expended for the Cristobal coaling plant and \$42,771.88 for the fuel-oil plant. At the Pacific terminal \$3,062,379.61 were expended for the dry dock and \$953,332.82 for dredging the inner harbor; for the coaling station, \$920,226.68; Balboa shops, \$232,418.97; fuel-oil plant, \$58,068.42; for permanent townsites, \$278,011.34, and for permanent buildings, \$1,019,089.82; at Mount Hope for sanitary fill, \$22,089.62, and for the construction of roads, not including townsites, \$76,877.03.

For maintenance and operation \$6,999,750.15 were expended, as against \$4,123,128.09 last year. The main item of expense was \$3,513,350.06 for dredging 12,430,209 cubic yards of material due to the slides, while during the previous year there were expended \$1,633,030.06 for the removal of 4,710,566 cubic yards of material from the same causes.

The tolls collected amounted to \$2,399,830.42, as against \$4,343,383.69 last year. Accompanying the detailed report of the auditor is a statement showing the tolls collected from each ship and the amounts that would have been collected under the Panama Canal rules. The business operations show a profit of \$11,898.44, as against the loss of \$56,400.78 last year.

Under claims for injuries and deaths, 2,349 accidental injuries and 39 accidental deaths of Panama Canal employees occurred in connection with their work. Of the injuries reported, claims in 741 cases were approved and 35 disapproved. Fourteen death claims were approved and 6 were disapproved, while 19 cases were pending at the end of the year. On account of injuries to employees \$32,341.85 were allowed, and on account of deaths \$33,321.07. To employees of the Panama Railroad \$9,056.66 were allowed for injuries, and \$3,330.24 were allowed on account of deaths. The total amount paid by The Panama Canal as compensation on account of injuries and deaths of employees since August 1, 1908, the effective date of the act of May 30, 1908, was \$1,338,653.69.

Coupon books to the value of \$3,250,132.50 were issued during the year to employees on pay-roll deduction. Commissary and hotel coupon books to the value of \$1,615,903.80 were sold for cash. Meal tickets to the value of \$126,397.87 were issued to silver employees.

The accounts of all officials and employees charged with the collection, disbursement, or the custody of Panama Canal and Panama Railroad funds, or with funds which were semipublic, are examined at frequent and irregular periods, as contemplated by the regulations.

For further details attention is invited to Appendix H.

## EXECUTIVE DEPARTMENT.

The department embraces the various civil functions pertaining to the government of the Canal Zone, the courts, the offices of the special attorney and the district attorney, and the Canal Record. It is in charge of Mr. C. A. McIlvaine, executive secretary, acting under the Governor. The organization of the executive department and of the executive office was continued along the lines set forth in the annual report for 1915.

## DIVISION OF CIVIL AFFAIRS.

The work of the customs, posts, local licensing, administration of estates of deceased employees, shipping commissioner, and publication of the weekly bulletin, the Canal Record, was carried on by this division.

*Shipping commissioner.*—The shipping commissioner exercised practically the same powers as are exercised by American consuls in foreign ports. As this power was questioned Congress was requested to enact legislation making it definite, and provision was made in the act approved August 21, 1916, accomplishing the purpose. In the same connection, the diplomatic and consular appropriation act, which became a law on July 1, included The Panama Canal Zone in the countries to which relief and protection of American seamen would be extended.

*Customs.*—On September 15 the Government of Panama was notified that the existing Chinese exclusion laws would not be held to apply to Chinese crews of vessels. Customs officers were directed to continue checking the Chinese crews, but to make no further effort to prevent them from coming ashore in the Canal Zone.

The act of August 21, 1916, confers upon the President authority to make rules and regulations touching the right of persons to enter the Canal Zone, and besides other things, to require a ship bringing an undesirable to the Canal Zone to return him to the place of origin.

During the year 395 prohibited aliens arrived at Balboa and 158 at Cristobal, in transit to the Republic of Panama and other countries. By authority of the Panaman officials 343 were allowed to disembark, 1 escaped, 3 were transferred to their vessels or returned to the port of embarkation, and 206 were transferred passengers.

The customs bureau and police division are in possession of information indicating that large quantities of opium are smuggled through the Canal Zone into the Republic of Panama and that a considerable portion is later smuggled into the United States. Every effort has been made to break it up, but the traffic is so profitable that it can only be stopped by assessing heavy fines and giving long prison sentences. The penalty for smuggling opium is a maximum



fine of \$5,000 and a minimum fine of \$50 and imprisonment not exceeding two years, or both such fine and imprisonment. There were 38 arrests of persons and vessels on this charge, of whom 7 were acquitted. In the majority of cases found guilty the minimum fine only was assessed. The largest fine assessed any individual was \$100 and the heaviest fine against a ship was \$190. It is difficult to cope with the problem when such penalties are inflicted.

The total number of vessels entered at the canal ports was 2,130, and the total number of vessels cleared was 2,123. There were 2,631 seamen shipped on American vessels and 2,475 seamen discharged.

*Licenses and taxes.*—Licenses and permits were issued to the number of 2,569, of which 1,078 were for motor vehicles. Motor-vehicle license fees in the Canal Zone have been considered excessive, and by the act of August 21, 1916, the President is given power, among other things, to make rules for regulating licenses and taxing the use or operation of all self-propelled vehicles using public highways in the Canal Zone. Under this law the license fees may be reduced.

*Postal service.*—Postal receipts for 1916 were \$1,060.90 more than the previous year; the expenses were \$9,739.19 less. The deficit was \$44,527.14, as compared with \$55,327.23 in 1915. In connection with this deficit it must be remembered that the postal service is still burdened with a subsidy to the Panaman Government equivalent to 40 per cent of its total stamp sales, amounting to \$27,207.86 in 1916, and that the service has not been allowed credit in the accounts for interest earned by money-order and postal-savings funds deposited in banks, amounting in 1916 to about \$39,000. This latter handicap, however, is removed by the act of August 21, 1916.

Deposit money orders issued had a total value of \$1,101,190 and payments of deposit money orders during the same period aggregated \$1,103,340, leaving a balance on deposit, June 30, 1916, of \$350,650. These deposit money orders form the postal savings system on the Canal Zone and draw no interest. Under the act of August 21, 1916, however, interest will be allowed at the rate of 2 per cent.

Mail addressed to ships transiting the canal is sent to the office of the captain of the port at which the ship is due to arrive first, and is delivered to the ship by the boarding officer of the customs service, who is also prepared to sell stamps, accept letters for registry, as well as ordinary mail, and furnishes applications for both domestic and international money orders, taking the money from the remitter and issuing a receipt.

At present the service is confronted with the serious problem of the rifling of registered mail dispatched to the different islands of the West Indies, and this matter has become so serious that it is necessary to forward all such mail through the New York exchange post office. The matter is under investigation.

In June, 1915, the limit of weight of mail matter of the third and fourth classes was raised from 11 to 20 pounds, to conform with the parcel post weights in effect in the United States.

*Canal Record.*—The Canal Record is devoted to the publication of shipping news, statistics of traffic, Executive orders, official advertisements, notices, and circulars. The cost of publication was reduced from \$13,585.15 in 1915 to \$10,806.28 in 1916. Collections on account of subscriptions and the sale of extra copies and bound volumes amounted to \$561.50.

#### POLICE AND FIRE DIVISION.

Contrary to expectation, police work did not diminish during the year 1916 and the appropriations were therefore inadequate. Changes were made which resulted in the discharge of 23 second-class, or colored, policemen, and the reduction in pay of 42 first-class, or American, policemen, and 13 second-class. For military reasons the force of policemen on the locks was increased by 41 first-class officers on April 20, and these men were recruited from the military force on the Isthmus. A patrol launch was operated at the Pacific entrance of the canal to prevent smuggling and irregular trading, one at the entrance of Gaillard Cut, at Gamboa, and one at Gatun, making the regular inspection trips and assisting in the work of depopulating the Canal Zone. Continuous guard duty was performed by policemen at the Pedro Miguel and Miraflores Locks, and three plain-clothes officers were stationed at Gatun Locks, which were guarded by the military forces.

During the year 4,480 persons were arrested, of whom 274 were females. Of the 4,167 tried, 3,389 were convicted, 767 were discharged and 11 were awaiting trial at the close of the year. Of the remaining 313 arrested and held in custody, 4 were sent to the asylum for the insane, 64 were turned over to the military authorities, 43 to the quarantine authorities, 27 to the Panamanian Government, 3 were extradited, 8 forfeited their bail by failure to appear for trial, 97 were deported, and 66 were returned to merchant vessels. There were 5 homicides committed. One offender, a woman, was acquitted, 1 was sentenced to 1 year and 6 months in the penitentiary, 1 to 20 years, and 2 were awaiting trial at the close of the year.

In cooperation with the customs officers, special effort was made to break up the traffic in smuggled opium. Thirty-five persons were arrested, of whom 29 were convicted and 6 dismissed. Also 3 vessels were prosecuted, 1 of which was acquitted. Fines amounting to \$2,040 were imposed.

There were 59 convicts received at the penitentiary, a decrease of 7 as compared with the previous year. At the close of the year 51 remained in custody. Prisoners were employed on the construc-

tion of a new road roughly paralleling the canal on the east side, an extension of the highway from Panama to Gamboa, and 5 $\frac{1}{17}$  miles were completed. The labor performed on road work was valued at \$10,256.60, at the rate of 10 cents per hour, and the value of labor performed inside the prison, other than for maintenance, amounted to \$148.10. The cost of subsisting and guarding the convicts amounted to \$18,525.32, of which \$4,935.21 were expended for subsistence for convicts, \$1,356.32 for subsistence of guards, \$7,173.32 for salaries of officers and guards of the penitentiary, and \$5,061.03 for salaries of officers and guards on road work.

The fire force remained the same as at the close of the last fiscal year. The only important fire occurring in the Canal Zone was on the S. S. *Antonio Lopez* at Cristobal, which was extinguished after a loss of \$20,000.

#### DIVISION OF SCHOOLS.

Schools for white children were conducted at Empire, for the first six grades; Paraiso, first three grades; Pedro Miguel, first seven grades; Colon Beach, first four grades; Cristobal, eight grades and two years in high school; Ancon and Gatun, eight grades; Balboa, eight grades and four years in high school. Children living in villages where the schools did not offer the work for which they were fitted were furnished transportation to the nearest school furnishing proper facilities. The school at Corozal was closed November 19, 1915, and the children of officers and enlisted men of the Army quartered there were furnished transportation to attend school at Balboa.

Physical examinations of pupils in the grade schools were made in October. Physical training was continued under the direction of the physical directors of the various clubhouses.

A four-year commercial course was added to the high-school work at the beginning of the school year, and 45 pupils were enrolled. The subjects taught are bookkeeping, business law, commercial geography, commercial history, spelling, writing, commercial correspondence, business arithmetic, typewriting, and the Gregg system of shorthand. A two-months' vacation course of woodwork and shop drawing at the Balboa workshop was offered to boys who would be in the seventh and eighth grades of the high school at the opening of the school year in October. In the regular school terms industrial courses in the high schools were provided, including elementary mechanical drawing, advanced mechanical drawing, elementary woodwork, and advanced cabinet making. In the seventh and eighth grades at Balboa and Ancon courses in shop work were arranged for the boys, and while they were in the workshops the girls of these grades were given lessons in sewing by their respective teachers. The boys apprenticed at various trades in Balboa shops were given a course of instruction on Tuesday and Saturday after-

noons of each week at the Balboa high school, and their progress was more satisfactory than heretofore.

The schools for white children had an enrollment of 1,366. Alien employees of the canal and the Panama Railroad residing outside the Canal Zone had, prior to this school year, been allowed tuition to the schools free of charge. This privilege was withdrawn at the beginning of the year, and consequently four rooms in the Cristobal school for colored children and the entire Ancon school were closed and the force of teachers reduced by seven. The eight grades were taught at La Boca and Paraiso, and the first six at Empire, Gatun, and Cristobal. The number of children enrolled in the colored schools was 783.

Sixteen buildings were used for school purposes, 11 for white children and 5 for colored children. At Cristobal, on account of the noise caused by the construction of a new building, it was necessary to abandon the schoolhouse occupied by white children and to move the white school to the building occupied by the colored school. The colored school was removed to the Lodge Hall.

Sites for concrete buildings for white schools were selected at Balboa, Ancon, Pedro Miguel, Gatun, and Colon Beach. Money was appropriated for expenditure during the current year for this purpose, and it is expected that the new buildings will be ready for occupancy by the time the schools open in October, 1917.

#### BUREAU OF CLUBS AND PLAYGROUNDS.

Clubs and playgrounds were conducted, as in previous years, under the supervision of secretaries furnished by the international committee of the Young Men's Christian Association. Clubhouses for gold employees were operated at Cristobal, Gatun, Pedro Miguel, Corozal, Ancon, and Balboa and for silver employees at Gatun and La Boca. The clubhouse at Ancon, composed of the old district quartermaster's office and an extensive addition, was erected at a cost of \$21,863, derived from clubhouse funds collected since 1907, and was opened on April 8. The clubhouse at Corozal was closed November 15 and was taken over by the Army authorities. At Paraiso the Lodge Hall was used one evening a week for moving-picture shows. The clubhouse of the Balboa Yacht Club was opened on May 29. The Tarpon Club, organized for fishing at Gatun Spillway, constructed a clubhouse at the spillway from funds collected from memberships. A golf club was organized at Gatun and links were laid out on the slope of the dam between Gatun Locks and the spillway.

#### THE COURTS.

In the district court 89 cases were pending at the beginning of the year, 789 cases were filed and 752 decided, leaving 126 cases pend-

ing on June 30, 1916. Of the cases decided 91 were civil, 284 probate, and 377 criminal. There were 117 sessions of court. There were 581 marriage licenses issued by the clerk of the court, and 136 deeds recorded. The sum of \$4,761.80 was collected in fines, costs, and fees.

In the magistrate's court for the Balboa subdivision 4 cases were pending at the beginning of the year, 2,233 cases were docketed and 2,136 cases were settled, leaving 101 cases pending at the close of the year. Of the cases docketed, 96 were civil and 2,137 criminal. Of the criminal cases, 50 were dismissed, 233 were committed to the district court, and there were 1,606 convictions and 247 acquittals. Collections on account of fines and fees amounted to \$5,995.50.

In the magistrate's court for the Cristobal subdivision 5 cases were pending at the beginning of the fiscal year, 2,403 were docketed during the year, of which 125 were civil and 2,278 criminal, leaving 122 cases pending at the close of the year. The criminal cases resulted in 1,659 convictions, 410 acquittals, 60 dismissals, and 157 cases were committed to the district court. A total of \$6,053.53 was collected in fines and fees.

The district attorney, in his annual report, Appendix J, again comments on the results of jury trial, and recommends, as heretofore, that jury trial be confined to capital cases only. His statement is as follows:

The results of jury trials continue to be unsatisfactory, particularly with reference to white American defendants. Since the Executive order of July 4, 1913, authorizing jury trials in all felony cases, no white American has been found guilty when tried by a jury. This failure to convict is not due to lack of evidence or conflict of evidence. The evidence in many of the cases has been convincing, but the jurors are unwilling to convict and do not seem inclined to accept any responsibility for the enforcement of the laws of the Canal Zone.

I renew the several recommendations heretofore made that the Executive order be so amended as to permit jury trials only in capital cases.

#### RELATIONS WITH PANAMA.

Negotiations by correspondence or personal conferences between the executive secretary and the secretary of foreign relations of the Republic of Panama included, among others, the following subjects in addition to routine matters:

The exemption of contract laborers of The Panama Canal and the Panama Railroad, and their families, from payment of a deposit of \$30 required of each deck passenger arriving at any port of the Republic of Panama by Panama Immigration Law No. 32 of 1914; publication of the amended sanitary regulations for the cities of Panama and Colon in the Official Gazette; street cleaning and garbage collection in the city of Panama; ordinance respecting the registration of births and deaths; proposed cancellation of land leases held by the Republic of Panama in Colon; preservation of the neutrality of the Canal Zone; immigration of undesirables; sale of

intoxicating liquors to the San Blas Indians; free railroad transportation for Panaman Government officials and employees; regulation of traffic over the Gatun Lake; payment of duty to the Republic of Panama on sales of supplies to vessels which pass through the canal and which do not belong to the United States; opium traffic in the Canal Zone and the cities of Panama and Colon; demolition, for sanitary reasons, of stables located in unimproved sections of the city of Panama; matter of imposing a penalty for wireless installations in Panama; objection to the establishment of saloons in Colon near the boundary line; importation of playing cards and tobacco for employees free of customs duty; overcrowded condition of Santo Tomas Hospital and the urgent necessity for providing additional accommodations for the sick; taking over by the United States of a certain tract of land in the vicinity of the mouth of the Chagres River; location of the statue of Christopher Columbus at the Atlantic entrance of the canal; reduction of the stock of Panaman pesos in circulation by 1,000,000 for the benefit of the Panaman Government, The Panama Canal, and business interests generally; proposed common incinerator for disposing of garbage from Balboa, Ancon, and the City of Panama; supervision of the Panama elections; prohibition of gambling in the cities of Panama and Colon; and the deportation of undesirable Americans.

Attention is called again to the necessity of an agreement between the two Governments of the United States and Panama for modifying the Taft agreement, which is, in many respects, disadvantageous to both Governments, and should be substituted by an agreement made in accordance with our present mutual needs and with our rights under the treaty.

For further particulars attention is invited to Appendix I.

#### LAW.

During the year Judge Frank Feuille continued as special attorney, for the purpose of codifying the laws of the Canal Zone and defending the interests of the United States before the Joint Land Commission in the acquisition of lands under private ownership, which are being taken over in accordance with the Executive order of December 5, 1912. He also acted as adviser to the Governor and the various heads of departments in matters relating to the canal organization and administration and affairs arising between the Canal Zone and the Republic of Panama.

The only Executive order prepared was that of October 16, 1915, which provides for an annual recess of the Joint Land Commission, appointed under Articles VI and XV of the Panama Canal treaty. Bills were drafted for submission to Congress providing amendments to the existing road laws; the laws relating to the licensing of motor vehicles; the police and sanitary regulations, including those re-

lating to quarantine; and the laws relating to taxation. Most of these subjects were incorporated in a bill presented to Congress by the Hon. W. C. Adamson, chairman of the House Committee on Interstate and Foreign Commerce, which committee has jurisdiction of canal matters.

During the last fiscal year the land office settled by private agreement and paid 586 claims, aggregating the sum of \$335,740.50. This amount includes the large claim of Gov. Reuben S. Arcia, of Colon, for his Rio Indio and Mindi lands and improvements thereon, for the sum of \$95,000. The total number of claims settled and paid by the land office since the work of clearing the Canal Zone was commenced on January 1, 1913, was 4,182, aggregating the sum of \$851,566.64, exclusive of any award made by the Joint Land Commission. A total of 5,244 claims, aggregating a sum of \$1,100,469.94, has been settled and paid through the law department since August 1, 1908, when that department was authorized by Executive order to handle such matters.

The Joint Land Commission appointed under Articles VI and XV of the Panama Canal treaty made 18 awards during the year. These awards involved 27 claims, some of the claimants having more than one claim before the Commission. The 18 awards aggregate the sum of \$10,675. The Commission dismissed 854 claims because payment had been made by the land office, and 16 were dismissed on account of insufficiency of the evidence. One claim was dismissed at the request of claimant's counsel because the property is not located within the Canal Zone, and one was dismissed for want of jurisdiction. The total number of dismissals by the Commission was 872. The Commission disagreed in 15 cases, in 6 of which certificates of disagreement covering 9 docket numbers were perfected and submitted to the umpire during the fiscal year.

It is of interest to note that the work done by the Commission during the period covered by this report cost the United States \$45,524.38, of which \$44,664.65 were for salaries and \$859.73 for expenses; this sum does not include the proportionate share of expenses of the special attorney's office. The number of cases pending on June 30, 1916, was 1,020, and the claims filed for these aggregated \$12,308,834.15. Five of the awards made by the Commission related to land claims and 17 were for improvements only.

Admiral Victor Maria Concas y Palau was appointed umpire by the President of the United States and the President of Panama, under the provisions of Articles VI and XV of the Panama Canal treaty, and arrived on the Isthmus on April 10, 1916. The umpire rendered four decisions, involving 17 claims, aggregating the sum of \$50,662. Two of these awards were for land claims and 15 for improvements only.

On June 30, 1916, there were 32 licenses in effect, which were issued by the land agent for The Panama Canal within the Canal Zone. These licenses included lots occupied by various oil companies for oil-tank sites, church lots, and one license for 2 acres of ground at Porto Bello. The total rental collected on licenses was \$10,918. This is a considerable increase over the previous year, because of the fact that since January 1, 1916, all rentals from the Mount Hope tank farm were collected by The Panama Canal instead of the Panama Railroad Company.

For further particulars attention is invited to Appendix K.

#### HEALTH DEPARTMENT.

The health department is charged with the care of the sick and injured of the Canal Zone, the prevention of disease in the Canal Zone and the cities of Panama and Colon, street cleaning and garbage removal in the latter cities, and all matters relating to quarantine. The department was in charge of Lieut. Col. Charles F. Mason, United States Army, until June 7, 1916, when he was relieved at his own request on account of ill health from long service in the Tropics. He was succeeded by Lieut. Col. D. C. Howard, United States Army, who was assigned to duty as chief health officer on June 22, 1916.

No cases of yellow fever, smallpox or plague originated on the Isthmus during the year. Four cases of yellow fever were received at Balboa quarantine, all from Buenaventura, Colombia. No secondary cases developed.

The health of employees continued good. The total admission rate to hospitals and quarters was 301.09, compared with 337.21 for 1915. Rates are based on the annual rate per 1,000 employees. The total admission rate to hospitals only for the year was 164.78, compared with 204.18 for 1915; and for disease alone, 125.88 as compared with 156.81 for 1915. The total death rate for 1916 was 6.65, as compared with 5.78 for 1915, and the death rate from disease 4.98 as against 3.61 for 1915. Conditions with regard to malaria are improving steadily each year. The total admission rate for malaria to hospitals and quarters was 34, as compared with 66.60 for 1915, a reduction of 48 per cent from the rate of the previous year. The admission rate for typhoid fever was 0.18, as against 0.19 for 1915, and the death rate 0.12, as compared with 0.03 for 1915. The admission rate for dysentery was 0.80 as compared with 0.85 for 1915; and the death rate was 0.09 as compared with 0.05 for the previous year. The death rate for pneumonia was 1.16 as compared with 0.58 for 1915.

In the Canal Zone the death rate from disease was 11.02 as compared with 11.77 for 1915. In Panama the death rate was 27.27 as compared with 30.74 for the preceding year. In Colon the rate was 24.51 as compared with 21.25 for the previous year.



## DIVISION OF HOSPITALS.

The average number of patients constantly present in Ancon Hospital was 748 as compared with 802 for the previous year. The average number of employees constantly sick in hospital was 267 as compared with 331 for the previous year.

Wards 3 and 4 were vacated in August, 1915, demolished, and the first unit of the permanent hospital erected on their site was completed and turned over for occupancy in June. The building containing the out-patient clinic, X-ray apparatus and library was vacated and turned over to the building division in August, 1915, for use as a local field office. Wards 1 and 2 were vacated in June, 1916, demolished, and on their site construction was begun on the second unit of the permanent hospital. Wards 13 and 14 were vacated in June, 1916, demolished, and construction started on the new Board of Health Laboratory. The permanent concrete crematory building was completed, cremating apparatus set up, and operations resumed in January, 1916. Two permanent buildings were added to the hospital farm at Corozal; one a modern, concrete, fly-proof compost pit containing four compartments, and the other a carpenter shop. A steam plant consisting of boiler, pipe line, and sterilizer was constructed to provide for the proper sterilization of all milk containers, as well as the disinfection of beds and bedding.

There were 253 patients in the asylum on July 1, 1915; 146 males and 107 females. At the close of the fiscal year the number of patients remaining was 291, of whom 173 were males.

The farm was reorganized and the position of assistant farm manager created. At the close of the year there were 9 white and 44 black cripples assigned to the farm.

Considerable trouble was experienced with the milk from the dairy early in January, and a thorough investigation and examination of the probable causes were made by Physiologist G. C. Bunker, as the result of which improvements were introduced and more care given to the milk, with satisfactory results.

*Colon Hospital.*—A new hospital and dispensary building was completed and turned over for occupancy on May 16, 1916. Work is in progress toward the construction of a reinforced concrete garage, morgue, and a four-family type house for use of physicians. The present quarters for nurses are not satisfactory.

The number of patients at the Leper Asylum is constantly increasing. There were 56 at the beginning of the year and 65 at the close. Additional accommodations are necessary, and a new ward building was authorized.

Two line dispensaries were closed, Corozal and Naos Island, leaving 5 at the close of the year, not including the dispensaries at Ancon and Colon hospitals.

## PANAMA.

The rapid growth of the city eastward toward the Sabanas, away from the Canal Zone, has necessitated extending anti-mosquito work in that direction, including the construction and maintenance of extensive additions to the ditching. Up to the present time the cost of this work has been borne by the Government of Panama and the Panama Land & Development Co.

The Panama Railroad Company completed its public stables on B Street, which were constructed so as to limit fly breeding and rat infestation. This is one of the most important sanitary accomplishments during the year, and made possible the elimination of a large number of dirty, ill-kept stables in the most congested portions of the city.

An average of 5,000 loads of garbage of all kinds was collected per month, approximating 9,000 cubic yards, including house garbage, rubbish, refuse, and stable manure, all of which was hauled to the public dump for disposal. The erection of a modern incinerating plant for the destruction of garbage and refuse is an urgent necessity. Another necessity is the installation of a compost pit for treating manure with a view to making it available for fertilizer and at the same time obviating the possibility of fly breeding.

T-4

## COLON.

There has been a great improvement resulting from anti-malarial measures. The total number of cases reported for the last six months of the present fiscal year was 52, as compared with 99 for the last six months of the preceding fiscal year. The reduction was secured through the complete elimination of anopheles breeding on Manzanillo Island, in Colon and Cristobal proper, by a combination of ditching and filling certain areas previously characterized by persistent breeding, as well as by increasing the number of weekly inspections of each area; and oiling when necessary.

## SANITATION.

The work of this division continued along the usual lines, covering anti-malarial work, the destruction of rats, the inspection of all residential districts in the Canal Zone, and the inauguration of measures for the correction of insanitary conditions wherever practicable. The experience gained has demonstrated that extensive work must be maintained constantly in and around residential districts to protect against malaria, but as the transition period from construction to operation advances there results greater permanency in locations in which employees work and have their homes, and work of a permanent nature can be done thereby reducing the cost of maintenance.

The increased number of ships at the terminal ports increases the opportunities for contamination of the Canal Zone by plague-infected rats. Men are employed to kill rats by all means possible, especially along the water fronts.

The number of sanitary districts remained the same as last year until Corozal was turned over to the military forces, when the inspection and upkeep of one-third of the district was assumed by the troops, and the remaining two-thirds added to Ancon, the inspector for which was allowed an assistant.

For further particulars, attention is invited to Appendix L.

#### WASHINGTON OFFICE.

The scope of the work handled by the Washington office was about the same as reported for the previous year. It continued in charge of Maj. F. C. Boggs, United States Army, as general purchasing officer and chief of the Washington office of The Panama Canal until March 10, 1916, when he was succeeded by Maj. Earl I. Brown, United States Army.

The recruiting of skilled mechanics in the United States was more difficult, especially during the latter part of the year, due to the activities at shipyards and other manufacturing establishments and the rising scale of wages paid at such plants. This is evidenced by the fact that about 48 per cent of those tendered employment failed to accept. During the year 1,176 persons within the United States were tendered employment for duty on the Isthmus in grades above that of laborer; 616 persons accepted and were appointed, covering 73 different positions.

The total value of orders placed by the Washington office was \$8,495,099.59, as compared with \$7,307,689.34 in 1914-15, bringing the grand total of purchases since 1904 to \$118,159,235.45. The principal items of equipment purchased during the year were 1 refrigerating plant, \$47,850; 1 engine lathe, \$36,960; sectional steel doors and accessories for piers Nos. 7 and 18, \$121,837.80; keel blocks and bilge blocks for Dry Dock No. 1 at Balboa, \$50,390.70; 4 wooden dump scows, \$120,000; 2 steel dump scows, \$160,000; 2 oil storage tanks, \$25,200; one 50-ton locomotive crane for Dry Dock No. 1 at Balboa, \$57,679.50; 11 capstans with motors for Dry Dock No. 1, Balboa, \$58,960; 1 tug, by transfer from the Corps of Engineers, United States Army, \$40,000; and boilers for the steamers *Ancon* and *Cristobal*, \$215,000. Shipments of cement were continued during the year under the contracts entered into January 7, 1909, and September 13, 1912, amounting to 528,465 barrels, making a total of 7,335,702 barrels delivered under these contracts.

For further details, attention is invited to Appendix M.

## FORTIFICATIONS.

Work was continued during the year on the gun and mortar batteries, on the range-finding and fire-control systems, on the mounting of ordnance, on the installation of searchlights, on maintenance of all completed work, and of clearings and trails connected with the fortifications.

The work was in charge of Lieut. Creswell Garlington, United States Army, until November 1, 1915, when the fortification division was abolished and added as a section to the work of the engineer of maintenance under Lieut. Col. Jay J. Morrow, assistant to the engineer of maintenance, with Lieut. Garlington as assistant engineer.

During the fiscal year a part of the work of maintenance of clearings and trails was transferred to the Commanding General, United States troops, Panama Canal Zone, and at the close of the fiscal year all fortification work was transferred to Maj. Clarence O. Sherrill, Corps of Engineers, Canal Zone district engineer officer, reporting to the Chief of Engineers, United States Army.

The following appendices are inclosed herewith:

Increase in salaries and personnel, submitted in compliance with the act of Congress approved March 3, 1915, Appendix P.

Laws recently enacted affecting the canal, and Executive orders issued during the year, Appendix Q.

Chart showing the organization effective July 1, 1916, Appendix R.  
Respectfully submitted.

GEO. W. GOETHALS,  
*Governor, The Panama Canal.*

HON. NEWTON D. BAKER,  
*Secretary of War, Washington, D. C.*

## APPENDIX A.

### REPORT OF THE ENGINEER OF MAINTENANCE.

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THE PANAMA CANAL,  
OFFICE OF THE ENGINEER OF MAINTENANCE,  
*Balboa Heights, Canal Zone, July 31, 1916.*

SIR: I have the honor to submit the following report of work done under the jurisdiction of this office during the fiscal year ending June 30, 1916:

#### ORGANIZATION.

The duties of the engineer of maintenance remained as outlined in the last annual report, except that on November 1, 1915, the fortification construction work was transferred to the jurisdiction of the engineer of maintenance, and on June 1, 1916, the work remaining uncompleted under the terminal construction division was transferred to his charge.

The undersigned has been assisted in these duties since August 19, 1915, by Lieut. Col. Jay J. Morrow, Corps of Engineers, United States Army, who was on that date appointed assistant to the engineer of maintenance, and who for a period of about five months has had full charge of the work during the absence of the undersigned on leave and when the undersigned was Acting Governor during your absence from the Isthmus.

The various divisions have been in charge of the following men:

*Electrical division.*—Capt. William H. Rose, United States Army, electrical engineer, and Mr. Hartley Rowe, electrical superintendent.

*Fortification division.*—Lieut. Creswell Garlington, United States Army, assistant engineer.

*Locks division.*—The Atlantic locks have continued under the direct charge of Capt. T. H. Dillon, United States Army, as superintendent, with Capt. Earl J. Atkisson, United States Army, as assistant superintendent. The Pacific locks were under the charge of Mr. F. C. Clark until March 2, 1916, upon which date he resigned, and Mr. R. H. Whitehead was appointed superintendent, effective the same date. Mr. W. R. Holloway was appointed assistant superintendent, effective March 2, 1916, vice Mr. Whitehead.

*Terminal construction division.*—Effective June 1, 1916, the work of the division of terminal construction, under Mr. H. H. Rousseau, civil engineer, United States Navy, was transferred to the undersigned, with Mr. F. H. Cooke, civil engineer, United States Navy, as designing engineer; Mr. C. C. Snedeker, superintendent, east breakwater; Mr. T. B. Monniche, engineer of docks; Mr. A. H. Jones, assistant engineer, Pacific terminals; Mr. J. W. Wright, superintendent of erection, Pacific terminals; Mr. R. A. Wilson, junior engineer, concrete block plant, Gamboa.

*Municipal division.*—Mr. D. E. Wright, municipal engineer.

*Section of meteorology and hydrography.*—Mr. F. D. Willson, chief hydrographer.

*Section of office engineer.*—Mr. C. J. Embree, office engineer.

*Section of surveys.*—Mr. O. E. Malsbury, assistant engineer.

## LOCK OPERATION AND MAINTENANCE.

### WATER STORAGE AND CONSUMPTION IN GATUN LAKE.

There are several plates accompanying this report which are intended to give a graphical illustration of certain items of interest in the operation and maintenance of the locks and canal.

Referring to plate No. 62, the upper diagram gives the number of inches of rainfall for each month throughout the year, the figures given being the record for Gatun Lake area and not for the whole Isthmus. The next diagram gives the average Gatun Lake level, while the third shows the number of lockages (commercial and non-commercial) which were made during each month of the year. The next diagram indicates the number of million cubic feet of water added to and taken from storage. That is, whenever Gatun Lake level is raised, the storage capacity is increased and the amount of water so accumulated is indicated by the areas above the neutral axis, while water drawn from storage is shown by the areas below the line. The lower diagram on this plate illustrates the quantity of water available throughout the year and the relative amounts actually used. The following table gives the average quantity of water available and a statement of how it was used:

	Million cubic feet of water.
Average monthly loss by evaporation, Gatun Lake.....	1, 926. 61
Average monthly loss by wastage over Gatun spillway.....	12, 787. 47
Average monthly loss by leakage, Gatun spillway.....	9. 59
Average monthly loss by transfer to Miraflores Lake.....	65. 06
Average monthly loss by leakage, Gatun and Pedro Miguel Locks.....	41. 37
Average monthly amount used for pumping.....	68. 27
Average monthly amount used for lockages.....	575. 70
Average monthly amount used for hydroelectric station.....	2, 506. 41
Average monthly amount added to storage.....	150. 00
Total average net yield per month.....	18, 130. 46

It is interesting to note that an average of 7.21 million cubic feet of water has been used for each through lockage from ocean to ocean. The above figures show that an average of 12,787.47 million cubic feet of water was wasted over Gatun spillway, or sufficient water to make 1,773 through lockages each month. Based on 30-day operation, this would mean 59 lockages per day over and above the average traffic of the past year. In this connection, it may be stated that the maximum number of lockages which can be made in 24 hours is 48, assuming that one vessel leaves the upper flight at Gatun just as another enters the lower chamber, and vice versa, both chambers being used.

Plate No. 63 illustrates the comparison between the amount of water actually used during the year, and the total available amount wasted and in storage. This chart is based on the assumption that the whole channel has been excavated to its full depth of 45 feet, and

since the canal channel is at elevation plus 40 feet, a 40-foot channel would necessitate keeping the lake level above plus 80, therefore the water in storage has been taken as the amount which is available at all times above that elevation. The summation of the three areas—water used equals 5,127.93 million cubic feet per month; water in storage equals 28,050 million cubic feet per month; water wasted equals 12,787.47 million cubic feet per month—gives the total available amount for each month of the year. The area "Water used" includes leakage, lockages, hydroelectric, pumping, and evaporation.

Plate No. 64 illustrates the number of lockages made each month. The number of noncommercial lockages coincides with the number of noncommercial vessels, the reason for this being that no effort has been made to keep a record of the number of canal barges, tugs, launches, etc., which have been locked through from time to time. The number of commercial vessels exceeds the number of commercial lockages, owing to the fact that whenever possible "tandem lockages" are made, e. g., two vessels locked through at the same time.

Plate No. 65 illustrates the force employed by the locks division throughout the year.

The canal was closed to traffic from September 18, 1915, to April 15, 1916.

Unusual details in the operation or maintenance of the locks and dams are referred to in the following paragraphs.

#### ARROW SIGNALS.

Last year reference was made to the fact that 15-foot arrow signals had been mounted near the end of each approach wall, with the idea of using them for signaling to pilots. The signals were equipped with lamps and are visible both night and day. This year local manual operation of the signals has been abandoned and motor drives have been installed, which are controlled by switches mounted on the control boards. The remote control of the arrow signals was completed as follows:

Pacific locks, July, 1915.

Atlantic locks, August, 1915.

#### AUXILIARY CULVERT VALVES.

In November, 1915, it was necessary to install a new auxiliary culvert valve at Miraflores Locks (east wall) owing to the fact that the bonnet of the old valve cracked. The new valve has been designed and tested for extra heavy service. A better compression spring was installed on valve B-5 at Pedro Miguel in October, 1915, and its effectiveness is being observed.

#### BACK FILL AND GRADING.

Practically all back fill and grading work on the locks has been completed. The work at Pedro Miguel was completed in April, 1915; at Gatun Locks the east side was completed in March, 1915, the west side in June, 1915. At Miraflores Locks the grading and back fill on the west and upper east sides was completed in August, 1915, while the lower east side work is still under construction.

## BRONZE BOLTS.

On October 10, 1915, the engineer at Gatun hydroelectric station advised that the counterweight of spillway gate No. 13 had given way and had dropped into its pit, demolishing all weights. This machine had not been operated for several days and was not being operated at the time of the accident. Upon investigation it was found that all four manganese bronze counterweight bolts had given way just under the head.

Each spillway counterweight consists of 56 cast-iron blocks weighing 750 pounds each, resting on a cast-iron base plate and supported by four 1½-inch manganese bronze bolts running into a cast steel yoke at the top. The total weight of the counterweight is 45,700 pounds, and assuming that the load is equally distributed, each bolt supports 11,425 pounds, or a stress of 4,750 pounds per square inch of metal. Sections of the bolts were sent to the mechanical division for test, and gave an ultimate tensile strength of 61,400 pounds, and 63,900 pounds per square inch, respectively, for the two bolts tested. This would indicate a factor of safety of about 13.

Immediate instructions were issued to the lock superintendents requesting them to examine the guard valve counterweight bolts and to replace all bronze with steel if any defective ones were found.

On October 21, 1915, the naval bronze U-bolt supporting the counterweight of guard valve No. 226 at Gatun failed, dropping the counterweight into its well. The guard valve was not being operated at the time of the break and had not been closed for some time. Upon examination two fractures were found, one at the top of one of the nuts on the bolt, and the other at the shoulder of the U opposite the first break. The fracture just above the nut was crystalline in appearance, with what appeared to be a fibrous formation at right angles to the length of the bolt. The fracture at the shoulder was about one-third fibrous and two-thirds crystalline, a vertical crack 1 inch long showing on one side of the bolt marked the plane between the two formations.

The total dead weight of the guard valve counterweight is 28,580 pounds, which under normal conditions would make the load on each leg of the U bolt 12,300 pounds (with the counterweight immersed). Assuming the worst condition, that of throwing the entire load (24,600 pounds) on one leg of the U bolt, the stress would be 13,900 pounds per square inch. If the load were equally divided between the two legs, the stress would be about 6,950 pounds per square inch, or an indicated factor of safety of nearly 9.

Under date of December 29, 1915, the Pacific locks superintendent advised that an examination of Miraflores spillway counterweight bolts resulted in finding two bolts broken off at the head and others with surface cracks indicating probable failure. Both of the broken bolts had failures with a crystalline fracture, and no observable reduction in area or elongation.

As a result of the above investigations and failures all counterweight bolts of the spillway gate machines have been replaced with steel, and bronze bolts are being replaced with steel wherever failures occur.



## BULKHEADS, CENTER WALL.

At Gatun the middle level, west bulkhead was not removed, but the other five bulkheads were taken out and coated with enamel at the time the gates were protected. At the Miraflores Locks the bulkheads on the east side of the center wall were removed and coated with enamel, the work at the Atlantic and Pacific locks being completed on the following dates:

Miraflores, center culvert, east lower level, June 15, 1916.

Miraflores, center culvert, east upper level, chamber side, March 14, 1916.

Miraflores, center culvert, east upper level, culvert side, March 24, 1916.

Gatun, center culvert, east and west bulkheads, July 15, 1915, and October 15, 1915.

## CABLE CROSSOVER TUNNEL AND PUMPS.

The last two cable crossover sump pumps at lower Miraflores were installed during August, 1915, making the final dates of completion of the installations as follows:

Place.	Number of pumps.	Date.
Gatun.....	6	May 9, 1915
Pedro Miguel.....	4	Apr. 10, 1915
Miraflores.....	6	Aug. 26, 1915

The installation of these pumps has kept the tunnels comparatively dry, all linings having been cleaned and oiled during the year.

## CAISSONS, SPILLWAY.

The spillway caisson for Gatun was painted and placed in the water in September, 1915.

Miraflores spillway caisson has been enameled and will be placed in the water when the west chamber at Miraflores is flooded during the next fiscal year.

## CAISSON, LOCK FLOATING.

The floating caisson was received upon the Isthmus on October 29, 1914, and was practically out of service, except for tests, until July 15, 1915, upon which date arrangements were made to move it to the lower east chamber at Gatun Locks where the pumps were started in order to drain the locks during the painting of the gates. After the completion of the maintenance work on the gates and valves at Gatun on November 6, 1915, the caisson was tied up to the upper east wing wall until April, 1916, when it was towed through the Cut and locked down to the lower east end of Miraflores where work was commenced in the cleaning and painting of the valves and gates at that point. Immediately after the installation of the caisson at Miraflores it was noted that poor results were being obtained from the pumps, and upon dismantling them it was found that practically one-third

of the cast iron impellers of the machines had been eaten away through electrolytic or corrosive action, practically putting the pumps out of commission so far as effective work was concerned. Additional impellers have been ordered, and as soon as received the caisson will be entirely overhauled and put in first-class condition. (See Plates Nos. 10 and 11.)

#### CHAIN FENDER MACHINES.

On September 4, 1915, the S. S. *Luz Blanca* approached the lower end of Miraflores Locks while the chain fender was up and the semaphore in the danger position. The vessel struck the fender and without appreciably stopping its headway broke the chain and went through into the lock chamber. The fact that the machine had been blocked made it impossible for the fender to operate, but nevertheless the apparent ease with which the vessel went through the chain called attention to the desirability of a working test to determine the effectiveness of the fenders, and a committee was appointed to make a series of tests upon one of the chain fender machines at Gatun. The report of the committee is quoted as follows:

#### CHAIN FENDER TEST.

1. In accordance with your instructions of October 21, 1915, a board composed of Captain T. H. Dillon (Chairman), Captain E. J. Atkisson, Mr. F. C. Clark, Mr. R. H. Whitehead, and Mr. C. J. Embree, arranged to make tests of chain fender machines under service conditions. These tests were carried out on chain fenders Nos. 810-811 at Gatun Locks with the S. S. *Allianca* on October 26th, with six locomotives on November 5th and with the S. S. *Cristobal* on November 16, 1915. Report of tests follows:

#### PREPARATORY WORK ON MACHINES.

2. Ross valves, auxiliary valves and needle valves were examined, chain was cleaned of grease so the hawse pipe friction would correspond to previous tests. Tanks were washed out and machines were placed in what was considered a normal condition of maintenance. The proper instruments were installed to secure data desired. For the first test (S. S. *Allianca*) the valves were set to open at 360 lbs. at 12 notches opening of needle valves.

#### PROTECTION OF BOW OF SHIPS.

3. A rope mat 25 feet long and 2 feet in diameter was woven through and around the chain and a rope mat 2 feet thick hung over stem of the ship. A timber fender was used on the first run with the S. S. *Allianca* in addition to the rope mat, but was removed on later runs as serving no useful purpose. Rope fenders were hung from lock walls and men stood-by to drop fenders between ship and walls if necessary. No damage to ships occurred as result of test. There was no appreciable tendency of ship to sheer off on striking chain. Six locomotives were attached to ships to assist them in getting up speed and for braking if necessary. No braking was done by locomotives except on one test where valves were blocked open intentionally to determine pressure due to friction of water in pipes with open valves.

#### DATA OBTAINED.

4. The data obtained consisted of the following:
  - a. Total displacement of ships.
  - b. Speed at instant of striking chain. *Note.*—Ships' propellers were stopped before striking chain.
  - c. Distance travelled after striking.
  - d. Time interval between striking and stop.
  - e. Pressure gauge readings at 5 sec. intervals on high pressure cylinders.
  - f. Vacuum gauge readings at 5 sec. intervals on low pressure cylinders.
  - g. Pressure time diagrams of cylinder pressures.
  - h. Distance time diagrams of cylinder movements.

- i. Simultaneous time interval signals were installed for second and third tests.
- j. Travel time diagrams were taken for movements of one Ross valve on *Cristobal* test.

5. Similar runs were made differing by only one variable so that the effect of change in this variable could be determined; for example, changing between runs only the number of valves in operation, or speed of ship, etc.

#### TEST WITH S. S. "ALLIANCA."

6. Twelve runs were made with the S. S. *Allianca* (total displacement, 4,221 tons) at speeds varying from 1.23 miles per hour to 3.38 miles per hour. The distances traveled after striking chain varied from 14.5 feet to 52 feet. The setting of auxiliary valve was changed from 360 lbs. to 250 lbs. for the 8th run, also various openings of the needle valve from 6 to 15 notches.

7. The result of these tests was satisfactory as showing a sufficient strength of chain and the opening of the Ross valves under pressure. They were unsatisfactory in that the Ross valves did not always function properly in maintaining a uniform resistance pressure. Except on the 5th and 8th runs, the valves either remained open or closed only after an interval of time during which interval the valves offered no appreciable resistance to outflow of water and paying out of chain. The only resistance of any moment tending to stop the ship with one or more valves fully open is the weight of the cylinders and friction of moving parts. Consequently, except on the 5th and 8th runs, the distances traveled by the *Allianca* after striking the chain exceeded the theoretical although the ship was stopped before it would have reached the gates. Had the ship been of greater displacement under same conditions of valve operation the resistance above mentioned would not in every case have prevented traveling the distance between chain and gates.

8. After *Allianca* tests were completed the machines and valves were thoroughly overhauled and placed in perfect operating condition.

#### LOCOMOTIVE TEST.

9. After overhauling the valves 6 locomotives (3 on each wall) were used to draw out the chain in much the same manner as would a ship, their cables being fastened to the center of the chain. The operation of the valves was more satisfactory than was the case in *Allianca* test, but there was still considerable fluctuation as evidenced by the pressure curve. This fluctuation was decreased by the use of springs installed to increase tendency of valves to close and maintain a more nearly constant pressure. It was to be expected also that the strain exerted by the locomotive would not be so nearly constant as that exerted by a ship.

#### S. S. "CRISTOBAL" TEST.

10. Everything was again placed in perfect operating condition for the test with the *Cristobal* (displacement 18,000 tons) and record indicator was placed on one Ross valve. Ten trial runs were made, all except two being at approximately two miles speed. The first run was made at 1.64 and the eighth at 2.45 miles per hour, the latter speed being the maximum that could be obtained in distance available. The operation of the valves in every way was satisfactory and the distance travelled after striking, corresponded closely with the theoretical. With auxiliary valves set at 360 lbs. and the needle valves at 12 notches and at 2.45 miles per hour speed the maximum pressure developed in the cylinders was approximately 550 lbs. per sq. in., the Ross valves opened and floated at approximately .7 inch rise and ship was stopped in 57.5 ft. which is almost exactly with the theoretical.

#### DAMAGE TO CHAIN AND HAWSE PIPE.

11. Examinations were made of chain and hawse pipes after the *Allianca* and *Cristobal* tests. After the *Allianca* test the links of chain subjected to wear were worn from 0 to 3/64 inch with about same wear on hawse pipes. The rope fender was not removed from center of chain.

12. Examination made after *Cristobal* test showed a maximum wear on chain and hawse pipe of 3/32 inch and approximately same wear on hawse pipe. One link being No. 7 from hawse pipe towards sheave when chain is up, was stretched 7/16 inch and bent about 3/16 inch. This same link also developed a flaw with opening 3/16 inch x 3/4 inch and about 1/2 inch deep. Two links at center of chain were bent 3/8 inch and two more about 1/16 inch. All other links were O. K. and no bending of links caused by traveling sheave could be observed.

## THEORY OF OPERATION.

13. The proper functioning of the chain fender machines when chain is struck by a ship depends upon the successful operation of two resistance valves which may be connected in parallel at each chain fender machine. At practically all chains including the chain under test these valves are of the Ross type the theory of which is as follows:

14. The water pressure in the main or upper chain fender cylinder caused by ship striking the chain is transmitted thru small pipes to an auxiliary valve of safety, spring, diaphragm type which opens at a certain pressure for which it may be set and permits water to flow from head of cylinder to the chamber in bottom of Ross valve. Connected to this same chamber in bottom of Ross valve is a small needle valve which permits the escape of a certain portion of water coming through the auxiliary valve depending on opening of the needle valve. The working part of the Ross valve consists of a movable stem having two pistons. The openings and parts are arranged to form a balanced system except for pressures from chain fender cylinder acting on top of 2" stem tending to close the Ross valve and the pressure transmitted through the auxiliary valve acting on bottom 6" piston tending to open the Ross valve.

15. When chain is struck the action of check valves closes the system and the pressure increases until auxiliary valve opens. This transmits the pressure to bottom of 6" piston of Ross valve, thus overcoming the effect of corresponding pressure on the top of 2" stem and causes stem to rise and opens the valve. The stem of the valve continues to rise and increases the opening until pressure in chain fender cylinder drops sufficiently to permit closing of the auxiliary valve whereupon the now unbalanced pressure acting on top of the 2" stem causes Ross valve to close, the water in bottom chamber escaping through the needle valve, which is set at small opening to permit a cushioning effect in the seating of the valve. This opening and closing of the Ross valve continues until a balance in pressure between the 2" and 6" pistons is obtained. This balance is struck when the pressure required on the 6" piston in order to hold the valve is the same as that required for discharging thru the needle valve the quantity of water entering through the auxiliary valve. Theoretically this should cause a fairly uniform resistance pressure slightly in excess of setting of the auxiliary valve.

16. The functioning of the Ross valves and the resistance to paying out of the chain are thus seen to depend upon the differential action of the auxiliary valve and the needle valve and the potential unbalanced pressure on top of the 2" stem which tends to close the valve. Increasing the setting of the auxiliary valve increases the pressure required to open the Ross valve. Increasing the opening of the needle valve decreases speed of opening and increases speed of closing of Ross valve, causing higher pressures. Decreasing opening of needle valve increases speed of opening of Ross valve and decreases speed of closing, causing lower pressures.

17. The pressure curves show that the initial pressures run considerably higher than the setting of the auxiliary valves. These high pressures cause wider opening of Ross valves than that which is merely sufficient to cause the desired resistance. The excess opening causes a rapid drop in cylinder pressure after reaching a maximum. The drop in pressure is further accelerated because the stem of Ross valve continues to rise and increases the opening until the cylinder pressure falls to point about equal to setting of the auxiliary valve. In other words, the valve is opening while pressure is rising, reaching a maximum and dropping to a point equal to setting of auxiliary valve.

18. The force tending to close the Ross valve is the cylinder pressure which sets on the top of the 2" stem. It is fully effective only when this pressure is less than setting of auxiliary valves, or when auxiliary valves are closed. The closing effort is greatest at instant of closing of the auxiliary valves, and rapidly decreases as the cylinder pressure decreases.

19. The closing of the Ross valve is further delayed by resistance to flow through the small opening of the needle valve, which delay serves to further accelerate the drop in cylinder pressure and consequently decreases the closing effort.

20. Being acted upon by a rapidly decreasing force the valve must be free to act quickly in order not to fail. Any undue friction or sticking in any one of the four valves in operation might cause the closing of the valve to lag behind the rapidly decreasing pressure, whereupon the closing effort would be lost and valves would remain open.

## EXPLANATION OF DIFFERENT RESULTS OBTAINED.

21. The only reason that can be ascertained for the different results of *Allianca* and *Cristobal* tests was the better condition for operation of the valves in the latter tests. As before stated, no special overhauling of valves was made before the *Allianca* tests

as it was desired to make same under normal condition of maintenance. The valves were merely taken apart and examined and tanks were washed out to prevent possibility of silt interfering with operations of the auxiliary valves. No attempt was made to have valves close of their own weight after being operated by hand as no necessity for this was foreseen. After the *Allianca* tests were completed the Ross valves were thoroughly overhauled, a new leather placed in one valve and the other leathers softened up. One valve stem which was sufficiently bent to cause valve to operate with difficulty when moved by hand was straightened in the lathe. Glands were loosened up so that valves closed by their own weight.

22. It is understood that the Ross valves are designed to reduce high pressure to lower pressure in same pipe system. In such a system there is always some pressure on the exit side, and consequently no opportunity for the pressure on the entrance side to drop to a point below which the unbalanced closing pressure could not overcome some considerable friction. On the chain fender machines, however, there is no appreciable resistance to flow beyond the valves as piping is short to air. A sluggish valve might work satisfactorily in a reducing system, but might fail under a chain fender test. Test No. 12, run with *Allianca* with Ross valve blocked open, indicates no appreciable pressure in cylinders. With open valves, therefore, or at slow speeds with partly open valves, the closing pressure is either not sufficient or drops too quickly, and their own weight is the only force tending to close the valves. With conditions as in chain fender machines, therefore, the adjustments of Ross valves and accessories must be carefully made and maintained. It is noted also that the sag of the chain was considerably greater in the *Allianca* test than in the *Cristobal* test, being 8 to 9 and 3 feet, respectively. Increase in sag serves to increase initial speed of cylinder travel, causing higher pressures and wider opening of Ross valves. High initial pressures offer more opportunity for failure of valves to close.

23. The result of the complete overhauling and installation of springs to assist closing of the valves was evident in the locomotive test, and to a smaller degree in the *Cristobal* test. The effect of the springs is negligible in opening. On the *Cristobal* test everything was operating so smoothly that minor changes such as variation in setting of auxiliary valves, needle valves, springs, use of one or both valves on each machine, change of speed, etc., while making appreciable difference, were not sufficient of themselves to cause valves to fail.

#### CARE OF VALVES.

24. Based upon result of these tests and also upon the fact that if any one of the four valves at each chain fender fails all would fail, the Board recommends the following, covering care and maintenance of the valves:

1. Valves should be thoroughly overhauled every 6 months, leathers softened up or new leathers placed and friction of moving parts eliminated so that valves close by their own weight.

2. One valve at each machine should be set with auxiliary valve to open at 300 lbs. and 6 to 12 notches (one to two complete turns) opening needle valve. The second valve at each machine should be set with auxiliary valve to open at 400 lbs. and needle valve set at 6 to 12 notches (one to two complete turns). Both valves should be connected in service and ready for emergency operations.

3. Install spiral springs on valve stems below valve to assist valve in closing. Strength of springs should be such that they will be only under slight compression when valves are fully closed and 100 lbs. compression when Ross valves are open one inch.

4. Reduce settings and operate valves with operating pumps, then reset as prescribed in paragraph No. 2 above, every three months.

5. Wash out tanks once in three months and make sure that there is no grit or silt to interfere with proper operation of auxiliary and needle valves.

6. Take off springs and operate by hand once a month to see that valves are operating freely and closing at their own weight. Then replace springs.

7. Operate valves by hand without removing springs once a week to keep them in smooth working order.

The result of the tests indicated that the chain fender machines would operate satisfactorily when properly adjusted and no difficulty would be encountered in stopping any vessel approaching the locks with a speed under 2 miles per hour. In addition to overhauling all chain fender machines and putting them in first-class operating condition, arrangements were made at the Pacific locks to put covers

over all regulating and needle valves to prevent unauthorized persons gaining access to or tampering with the adjustment of the mechanisms. Arrangements were also made to put ventholes in the top of all water tanks of chain fender machines in order to allow the escape of air at the time the machines operate. Ratchet-driven pawls have been installed on the lower chains at Miraflores, so that either the high or low tide chain can be easily thrown in. See Plates Nos. 66 and 67

#### CONDUCTOR SLOTS.

All conductor slots and rails have been overhauled, cleaned, and painted, putting both the towing and return tracks in condition for operation.

#### DECK LIGHTS.

Arrangements were made to replace practically all deck lights at the Pacific and Atlantic locks. It has been found that it is a very difficult matter to prevent the deck lights chipping and breaking out of the concrete as a result of being heated excessively by the sunlight and then suddenly quenched by tropical showers. The most effective means of preventing the breaking of the deck lights has been to paint the circumference of the light with a plastic compound, which allows for the expansion of the glass after being embedded in the concrete.

#### EMERGENCY DAMS.

As a part of the operating work at each of the locks two drill operations of the emergency dams are made each month, the usual crew being nine men. In order to accustom the men to operating under any condition, at least one of these operations is made at night under artificial light.

If the dams had to be operated in an emergency, the noise of the passing water would make it impossible to give verbal directions; therefore, all operations are carried out in silence, arrow signals being installed near the gates on each girder so that the silver operators can signal when the hooks are clear or in place on the gates. Additional lighting has been installed and an indicator has been placed on the gate machines for aligning the clutches so that the machines can be changed from one gate to the gate next without resetting. All clutch operating solenoids on the girder hoist machines have been removed during the year and will be operated by hand in the future. The Atlantic locks have installed lamps in each girder, gate, and wedge motor in order to keep the insulation dry and ready for service.

Upon checking up the quadrants of the emergency dams at the Pacific locks it was found that the east quadrant at both Pedro Miguel and Miraflores had settled, and arrangements were made to realign them, this work being completed in December, 1915.

#### FENDER TIMBER.

Timber fenders were installed at Gatun Locks in order to give additional protection to the walls between the upper and lower guard gates and the spring timber fenders as originally installed.

## GUARD VALVES.

The guard valves at all locks were originally installed with the decking poured in place, making it impossible to dismantle the valves without breaking out the concrete and removing the recessed covers. Arrangements are being made to put in steel cover plates in such a manner that any part of the guard valves may be dismantled and removed without cutting any concrete. In the near future arrangements will be made to remove all manganese bronze U-bolts on the guard-valve counterweights and replace them with soft steel bolts. This is the direct result of an accident which occurred at Gatun Locks under date of October 21, when one of the counterweights of guard valve No. 226 failed and dropped into its pit. At the Pacific locks experiments were made with one of the guard valves using a smaller motor, as the 25 h.p. motor gives a very high starting torque and wrenches the machines whenever they are operated. By adding approximately 3,000 pounds to the counterweight, it was found that one of the miter forcing motors, a  $7\frac{1}{2}$  h.p. machine would safely drive the guard valves, and arrangements have been made to install the smaller motor at the Pacific locks.

## HANDRAILS.

The usual maintenance work has been carried out in connection with handrails at all locks, and an examination of the motors has brought out the fact that their internal resistance is very low. Arrangements have been made to dry out all machines and an attempt will be made to keep them dried out by frequent operation or by the installation of lamps. A number of machine failures have occurred during the year, and arrangements have been made to strengthen the weak parts of the machine with resultant reliable operation.

## INTAKE SCREENS, CENTER AND SIDE WALLS.

At Gatun all intake screens were removed, cleaned, and given three coats of red-lead paint. One of the screens was coated with bitumastic enamel.

At Miraflores all center wall intake screens were removed, cleaned, and coated with enamel, the work being complete on April 13, 1916.

## LAMP STANDARDS.

The reflectors of all lamp standards have been enameled white during the year, giving very satisfactory illumination of the lock walls and chambers. Some experiments have been made with the use of nitrogen-filled 750-watt lamps, and very satisfactory results have been obtained. At the present time 500-watt tungsten lamps are used for the illumination of the lock walls, but at a future date these will be replaced with the higher power nitrogen-filled lamps.

## LIGHTING, TOWNSITE AND RANGE.

All channel range lights, which are electrically operated, have been connected up to the 2,200-volt service at Gatun, Pedro Miguel and

Miraflores Locks, respectively. The east and west channel range light circuits have been segregated so that either series of lights may be operated at will. Pedro Miguel townsite lighting mains were connected up to Pedro Miguel Lock service on September 25, 1915.

#### LOCKAGES.

Owing to the fact that the slides at Gaillard Cut interfered with the operation of the canal between September 18, 1915, and April 15, 1916, the number of lockages made during the year does not compare favorably with those of the last year. The following table gives the lockages at all locks, and the figures for Gatun include approximately 40 vessels which were locked into Gatun Lake on the south-bound trip and had to be returned to the Atlantic entrance owing to the slides.

Date.	All lock- ages.	Commer- cial lock- ages.	Commer- cial vessels.	Noncom- mercial lockages.
<i>Gatun.</i>				
To July 1, 1915.....	1,325	1,036	1,113	259
During fiscal year.....	929	713	867	216
To July 1, 1916.....	2,254	1,779	1,650	475
<i>Pedro Miguel.</i>				
To July 1, 1915.....	1,330	1,073	1,113	257
During fiscal year.....	987	752	812	235
To July 1, 1916.....	2,317	1,825	1,625	492
<i>Miraflores.</i>				
To July 1, 1915.....	1,317	1,070	1,113	247
During fiscal year.....	960	772	813	188
To July 1, 1916.....	2,277	1,842	1,926	435

In July, 1915, in order to economize in the number of pilots, the channel pilots were authorized to take ships through the locks. This plan did not prove satisfactory in all respects, and the procedure was changed in April, 1916, when arrangements were made to have the vessels transferred from the channel pilots to the lock pilots during lockage operations. The lock pilot takes charge of the vessel at the approach wall and releases it at the other end of the lock in a similar location, the transfer of responsibility taking place after the vessel has been tied up to the wall, although the change may take place in mid-channel, the respective pilots having the option of refusing to take charge and requesting that the vessel be tied up to the wall before accepting the responsibility of the vessel's safety. The lock pilots report direct to the lock superintendents and therefore the superintendents are directly responsible for all operations at the locks. Whenever possible, twin or "tandem" lockages are made, as this mode of handling the ships gives a considerable saving in water. The maximum over-all length ordinarily used is 750 feet, but exceptions have been made, as during September, 1915, Gatun Locks put through the S. S. *Kim* and the S. S. *William O'Brien*, having a total over-all length of 800 feet.

Whenever any maintenance work is being carried on in connection with the painting or repairing of the lock gates and gate valves, one



chamber is, of course, out of commission and necessitates the use of only one culvert in locking vessels through. The use of a single side-wall culvert increases the time of operation approximately 50 per cent over that required where both the side and center wall culverts are used.

In July and August, 1915, the battleships *Missouri*, *Ohio*, and *Wisconsin* were locked through from the Atlantic to the Pacific side and return. The time of operation for both sets of lockages was as follows:

## ATLANTIC TO PACIFIC.

	Arrived.	Entered.	Cleared.	Time.
<i>Gatun Locks.</i>				
Wisconsin, July 15, 1915.....	11.00 a. m.	11.08 a. m.	12.06 p. m.	<i>Min.</i> 59
Ohio, July 15, 1915.....	1.40 p. m.	1.47 p. m.	2.47 p. m.	61
Missouri, July 15, 1915.....	5.50 p. m.	6.03 p. m.	7.02 p. m.	60
<i>Pedro Miguel Locks.</i>				
Missouri, July 16, 1915.....	3.37 p. m.	3.56 p. m.	4.42 p. m.	47
Ohio, July 16, 1915.....	3.55 p. m.	4.07 p. m.	4.39 p. m.	33
Wisconsin, July 16, 1915.....	4.10 p. m.	5.10 p. m.	5.35 p. m.	26
<i>Miraflores Locks.</i>				
Missouri, July 16, 1915.....	5.23 p. m.	5.33 p. m.	6.21 p. m.	49
Ohio, July 16, 1915.....	5.40 p. m.	5.45 p. m.	6.38 p. m.	54
Wisconsin, July 16, 1915.....	6.22 p. m.	6.50 p. m.	7.30 p. m.	41

## PACIFIC TO ATLANTIC.

<i>Miraflores Locks.</i>				
Missouri, Aug. 31, 1915.....	9.15 a. m.	9.30 a. m.	10.20 a. m.	<i>Min.</i> 51
Ohio, Aug. 31, 1915.....	9.25 a. m.	9.35 a. m.	10.35 a. m.	61
Wisconsin, Aug. 31, 1915.....	9.48 a. m.	10.43 a. m.	11.22 a. m.	40
<i>Pedro Miguel Locks.</i>				
Missouri, Aug. 31, 1915.....	10.39 a. m.	10.49 a. m.	11.21 a. m.	33
Ohio, Aug. 31, 1915.....	11.05 a. m.	11.56 a. m.	12.28 p. m.	33
Wisconsin, Aug. 31, 1915.....	11.45 a. m.	1.04 p. m.	1.30 p. m.	27
<i>Gatun Locks.</i>				
Missouri, Aug. 31, 1915.....	7.05 p. m.	7.17 p. m.	8.32 p. m.	76
Ohio, Aug. 31, 1915.....	8.06 p. m.	8.29 p. m.	9.43 p. m.	75
Wisconsin, Aug. 31, 1915.....	9.59 p. m.	11.35 p. m.	12.50 a. m. (Sept. 1.)	76

## ELECTROLYSIS AND CORROSION.

*Lock gates.*—The most serious complication which has arisen during the past year has been the condition of the lock gates and valves over submerged areas.

The locks at the Pacific and Atlantic ends were originally watered on the following dates:

Gatun, west chamber, September 23, 1913.

Gatun, east chamber, January 3, 1914.

Pedro Miguel, west chamber, December 31, 1913.

Pedro Miguel, east chamber, October 14, 1913.

Miraflores, west chamber, October 14, 1913.

Miraflores, east chamber, January 12, 1914.

At the time the locks were watered all lock gates had been painted and put in first-class condition. The interiors of the gates were coated with enamel under a five-year guaranty, and the exteriors being protected with various kinds of submarine paints. The lock chambers had been drained at times, but no definite overhauling and maintenance work has been done until the past year.

When the floating caisson was received in December, 1914, it was installed in the lower east lock at Miraflores and the chamber pumped out, and an examination was made of the gates, valves, and fixed irons. They were found to be in good condition, although there was some rusting of the plates and rivets. As noted above, the east chamber was submerged in January, 1914, and the steel had been exposed for about 11 months. Upon the whole the gates were considered to be in excellent condition at that time.

During January and February, 1915, the west chamber at Miraflores was pumped out after being submerged about 15 months. The paint on the gates was blistering badly, but was still giving fair protection, although it was believed advisable to start in going over all gates at Gatun as they had been submerged since September, 1913.

The lock gates were originally coated throughout their interiors with bitumastic enamel and we had also authorized the protection of one of the spillway gates at Gatun with the same material. It appeared to give adequate protection in both places and as the contractor guaranteed the effectiveness of the enamel for five years, we entered into a contract providing for the coating of all lock gates at Gatun with bitumastic enamel. The caisson was transferred to Gatun and installed in the chambers on the following dates:

West chamber, north end, caisson in place, July 14, 1915.  
 West chamber, north end, caisson raised, September 5, 1915.  
 West chamber, south end, caisson in place, October 27, 1915.  
 West chamber, south end, caisson raised, November 2, 1915.  
 East chamber, north end, caisson in place, September 15, 1915.  
 East chamber, north end, caisson raised, October 15, 1915.  
 East chamber, south end, caisson in place, October 16, 1915.  
 East chamber, south end, caisson raised, October 27, 1915.

Upon examination of the interior of the gates at Gatun it was found that about 200 panels were in an unsatisfactory condition, and the contractor was required to recoat them with enamel in accordance with his contract. The condition of the paint on the exterior of the gates was as follows:

Gate No.	Condition of paint.	Date paint was applied.
1 to 4, inclusive.....	Very soft, considerable rust and pitting	June 14, 1913.
5 to 36, inclusive.....	Soft, blistered, but little rust.....	June, 1913, to Nov. 13, 1914.
37 and 38.....	Very little paint left, badly rusted.....	Oct. 15, 1914.
39 and 40.....	do.....	June, 1913.

A great deal of the paint was applied at the time the gates were originally accepted and is, therefore, the original painting, but some of it was applied as late as November, 1914. The enameling of the gates at Gatun was completed upon the following dates:

Gate No.	Upstream side completed.	Downstream side completed.	Gate No.	Upstream side completed.	Downstream side completed.
1 and 2	Oct. 11, 1915	Oct. 14, 1915	21 and 22	Sept. 27, 1915	Sept. 28, 1915
3 and 4	Aug. 3, 1915	Aug. 9, 1915	23 and 24	Aug. 5, 1915	Aug. 6, 1915
5 and 6	Oct. 6, 1915	Oct. 9, 1915	25 and 26	Sept. 30, 1915	Sept. 28, 1915
7 and 8	Aug. 18, 1915	Aug. 18, 1915	27 and 28	Aug. 4, 1915	Aug. 3, 1915
9 and 10	Oct. 12, 1915	Oct. 12, 1915	29 and 30	Oct. 1, 1915	Oct. 1, 1915
11 and 12	Aug. 13, 1915	Aug. 13, 1915	31 and 32	July 29, 1915	July 28, 1915
13 and 14	Oct. 8, 1915	Sept. 29, 1915	33 and 34	Sept. 27, 1915	Sept. 22, 1915
15 and 16	Aug. 10, 1915	Aug. 16, 1915	35 and 36	Aug. 2, 1915	July 27, 1915
17 and 18	Oct. 6, 1915	Oct. 5, 1915	37 and 38	Oct. 22, 1915	Sept. 21, 1915
19 and 20	Aug. 7, 1915	Aug. 7, 1915	39 and 40	Nov. 1, 1915	July 24, 1915

On the Pacific side no work has been done on Pedro Miguel Locks since the original painting and watering of the chambers. At Miraflores the east and west chambers were originally watered on January 12, 1914, and October 14, 1913, respectively. The chambers were not drained again until the floating caisson was received and tested out, when the chambers were unwatered and watered as follows:

Miraflores, east chamber, unwatered, December, 1914.

Miraflores, east chamber, watered, January, 1915.

Miraflores, west chamber, unwatered, January, 1915.

Miraflores, west chamber, watered, March, 1915.

At this time an examination of the gates and valves indicated considerable, but not serious, corrosion, and steps were taken to protect certain of the valves in the west chamber. The lock was again unwatered in February, 1916, when the pumping barge was installed at the lower end of the east chamber, the upper level being pumped dry by the 19th of the month.

Photographs illustrating the condition of the gates at Miraflores accompany this report.

Plate No. 2 shows a typical panel with its blistered paint and rusted area.

Plate No. 5 shows the appearance of the lower panels covered with sea growth—note the rusted spots.

Plate No. 1 shows a butt-strap and the typical pitting which has occurred on all gates.

Plate No. 4 shows the appearance of gate No. 116. The lower 4 panels had been submerged continuously since December, 1914. The next 3 panels were covered by the rise and fall of the tide, and the upper 10 panels were submerged only part of the time. Three kinds of paint were used on this gate—paint (a) on the lower panels, (b) on the next three panels, and (c) applied from this point up.

Plate No. 4 also shows an enlarged view of one of the lower panels of gate No. 116, and shows one of the worst cases of pitting that has occurred.

Steps have been taken to have the entire exterior of the gates coated with bitumastic enamel wherever they are wholly or periodically submerged. The balance of the lock gate leaves were painted as follows:

Steel surfaces submerged only during lockage operations were cleaned, and painted with two coats of red lead paint, with a finishing coat of Detroit graphite No. 30 marine brown. The remaining surfaces were given one coat of Detroit graphite No. 30 marine brown.

The gates in the east chamber at Miraflores were enameled complete on the following dates:

Gate No.	Down-stream side enameled.	Upstream side enameled.	Gate No.	Down-stream side enameled.	Upstream side enameled.
100-101...	1916. Mar. 8	1916. ( <sup>1</sup> )	116-117...	1916. Mar. 14	1916. Mar. 14
104-105...	Mar. 4	Mar. 2	120-121...	May 20	May 20
108-109...	Mar. 7	Mar. 7	124-125...	...do.....	...do.....
112-113...	Mar. 14	Mar. 14			

<sup>1</sup> Not finished.

The enamel placed on the gates has been guaranteed by the contractor for five years. Regarding gates Nos. 100 and 101, it may be stated that the enameling will be completed as soon as the caisson is again in operating condition.

*Cylindrical valves.*—Observations during the past year have shown that the corrosive action on the valves has been severe.

In July, 1915, Gatun Locks west chamber was drained and as a part of the maintenance work all of the accessible cylindrical valves were examined. It was found that marked corrosion was taking place on certain parts of the valves, although the entire valve was made of cast iron or steel, no bronze parts being adapted in the original design. It was found that in the lower level an average of 75 per cent of the seal segment nuts were corroded and an average of 106 per valve were required to replace those in bad condition. In some cases fully half the nut had disappeared and some idea of the more moderate cases may be obtained by referring to Plate No. 9. The original nuts were made of steel, but, for purposes of test, valve No. 502 was installed with 10 brass nuts on one seal segment, 10 refined iron nuts being installed on another segment. It was also found that the bolts holding the valve stops in place were in such a condition that they had to be replaced in every valve in the lower level. In valves Nos. 503-506 brass bolts 1 inch by 3½ inches were used in place of the steel ones taken out.

Similar conditions were found in the east chamber at Gatun when it was drained on September 16, 1915, in every case the corrosion being excessive in the lower level and gradually decreasing toward the Gatun Lake level. All valves were put into good condition and painted with red lead.

At the Pacific locks no examination has been made of the valves at Pedro Miguel or of those on the west side of Miraflores center wall. The east valves at Miraflores were found to be in fair condition. On February 24, 1915, cylinder valve No. 716 at Miraflores upper level was dismantled with a view of ascertaining the condition of the valve and stem and the tube for the valve stem in order to determine on the protective measures necessary.

The main part of the valve stem, consisting of three 16 feet 6-inch lengths of extra strong galvanized pipe, was in first-class condition, no sign of corrosion being apparent. The only sign of corrosion on any part of the stem was a one-eighth inch pitting which had occurred on the forged steel end of the valve stem. It was unnecessary to dismantle any of the other valves, as all parts requiring protection

from corrosion could be reached without the necessity of going to this extreme.

Inasmuch as all painted surfaces of the valve had failed, it was decided to coat all exposed iron and steel surfaces with enamel, and a contract was entered into with the American Bitumastic Enamels Co. for doing the work.

All cylindrical valves overhauled during the year were submerged on the following dates:

Gatun Locks, east chamber (coated with red lead paint), October 27, 1915.

Gatun Locks, west chamber (coated with red lead paint), November 2, 1915.

Miraflores Locks, east chamber (coated with enamel), June 15, 1916.

Pedro Miguel Locks, east and west chambers, and Miraflores Locks, west chamber, were not overhauled.

The cylindrical valves at Miraflores Locks, on the east side, were enameled complete on the following dates:

Valves Nos. 700, 702, 704, 706, and 708, March 24, 1916.

Valves Nos. 710, 712, 714, 716, and 718, March 23, 1916.

Valves Nos. 720, 722, 724, 726, 728, and 730, May 10, 1916.

Valves Nos. 732, 734, 736, and 738, May 10, 1916.

*Rising stem valves.*—All submerged iron and steel work of the rising stem valves have been submerged practically continuously since the locks were first watered on the following dates:

Gatun, east chamber, first watered January 3, 1914.

Gatun, west chamber, first watered September 23, 1913.

Miraflores, east chamber, first watered January 12, 1914.

The condition of the valves at Pedro Miguel has not been examined as yet.

The following is a detailed description of the condition of the various parts of the valves as found at the time the culverts were unwatered:

At both the Atlantic and Pacific locks there was considerable corrosion of the valves. The one-half inch plates have been attacked in a manner similar to that of the lock gates. In certain cases, such as the lower valves at Gatun, together with the upper and lower valves at Miraflores, they have been violently attacked on all rivets. Plate No. 7 shows a view of the bottom seal casting of one of the upper valves at Miraflores. Out of the 64 rivets on one butt-strap, 62 were practically eaten away and the remaining two were loose. It is also to be noted that the rivets outside the surface receiving the full static head on the valve are practically free from attack.

The bottom seal casting of the valve which comes in contact with the babbitt metal seal on the bottom of the valve is being rapidly eaten away, in many places the pitting being over three-sixteenths of an inch deep. A number of valves at the Pacific locks were in such condition that the bottom seal had to be machined off in order to make the valve tight. In order to protect the valve from any further electrolytic action between the cast steel seal and the lower babbitt metal seal, all babbitt metal has been removed and replaced with a seal of greenheart lumber.

*Side seals of valves.*—Some of the bronze side seals and springs were found to be broken, both at Miraflores and at Gatun. A number of the bolts on side seals at both Gatun and Miraflores were found broken.

With the above exceptions the seals were in good condition and only required a small amount of draw filing to make the contact surfaces perfect.

*Top gate seal.*—The top gate valve seal is of cast steel and is held in place by bronze bolts.

Plate No. 6 will give an idea of the amount of corrosion which has taken place—the worst cases being at the upper and lower valves of all locks. In practically every instance the corrosion has been excessive around the heads of the bronze bolts, cutting away the metal and in some cases allowing the bolts to loosen and fall out. Several castings had to be replaced, although in every case the rubber seal was still soft, pliable, and could have been retained in service. The worst case of corrosion of the seal occurred on the upper valves at Miraflores.

*Piers and side seals.*—At Gatun practically all valves were installed with fixed side seal castings, which all gave evidence of considerable corrosion, but not sufficient to cause any leaks.

At Miraflores removable side seal strips were of machinery steel (see Plate No. 8), and in every case corrosion had reached such a point that all side seals had to be replaced. Inasmuch as the corrosion had apparently been aided by the proximity of the bronze side seals which bear upon them, it was decided to replace all machinery steel with lignum-vitæ wood, in this way tending to place an insulating substance in contact with the bronze. All porous concrete around the fixed irons was removed and replaced with cement, and wherever babbitt metal had been used to fill the recessed holes for boltheads at the Pacific locks the metal was removed and replaced with cement.

*Roller trains.*—At both the Atlantic and Pacific locks there was considerable corrosion of the roller trains, the rollers of which are made of tool steel. At the Atlantic locks a number of rollers, bolts, and filler castings were found missing. All were replaced and the heads of all bolts were riveted over to prevent future losses.

At the Pacific locks similar conditions were found, and as it is impossible to protect the rollers by any paint, arrangements have been made to install  $\frac{1}{2}$ -inch pipes from the tunnel floors down to the base of the roller-train tracks. Crude oil will be forced through the pipes, and it is believed, from results of experiments made with a model, that the crude oil will rise along the surface of the roller-train track and in this way protect the rollers by coating them with oil.

*Conclusions.*—As a result of the examination of the valves at Gatun it was decided to have them coated with bitumastic enamel, although the fixed irons and roller trains were simply painted as a protection against electrolytic action. At the Pacific locks the experience obtained at the Atlantic end enabled more complete protective measures to be taken, the following being an outline of the work done:

(1) All bronze side seals were lined up and strips of zinc bolted to the valve each side of the seals at the bottom of the valve.

(2) Where necessary the bottom valve seal was machined off to give solid metal contact with the bottom seal.

(3) All removable side seal strips were taken out and replaced with lignum-vitæ wood strips. Where removable strips were not installed the fixed irons were milled down to take the wooden side seals.

(4) All babbitt metal used in the assembly of the valve for embedding and protecting boltheads from corrosion and for calking purposes was removed and replaced with cement.

(5) All babbitt metal used in the bottom seal was removed and replaced with greenheart lumber.

(6) All steelwork of the valve was coated with bitumastic enamel. This left only the bronze side seals exposed.

(7) All fixed irons were coated with bitumastic enamel.

(8) The channel iron supports for the rollers were coated with bitumastic enamel, and arrangements made to lubricate the roller trains and tracks with crude oil during operation and while the valves are submerged.

(9) All submerged portions of the valve stems were coated with bitumastic enamel.

(10) All bronze bolts are being replaced with steel as fast as breakage occurs.

The rising stem valves and fixed irons at Miraflores east chamber were completely enameled on the following dates:

Valve No.	Fixed irons enameled.	Valves enameled.
	1916.	1916.
414	Mar. 25	Mar. 25
415	Mar. 20	Mar. 30
416	Mar. 23	Mar. 23
417	Mar. 30	Mar. 30
420	Apr. 10	Apr. 10
421	Mar. 17	Mar. 17
426	Mar. 28	Mar. 30
427	Apr. 10	Apr. 10
428	Mar. 14	Mar. 29
429	Apr. 5	Apr. 6
432	Mar. 28	Apr. 4
433	Apr. 11	Apr. 1
434	May 25	May 25
435	May 29	May 29
438	June 3	June 3
439	May 26	May 26
440	<sup>1</sup> May 19	May 19
441	<sup>1</sup> May 10	May 10
444	June 7	June 13
445	June 7	June 7
446	Mar. 9	Mar. 9
447	Mar. 21	Mar. 30

<sup>1</sup> These valves were enameled under date of Feb. 27, 1915, and were touched up on the above dates.

Regarding the valves at Gatun, the dates of watering and unwatering the locks is given under the subject of "Lock gates."

#### MITER FORCING MACHINES.

Experience in operating has shown that the miter forcing machines are an unnecessary adjunct of the gates; therefore the motors, limit switches, and mechanisms have been removed from the gates, the work being completed in July, 1915.

#### PAINTING.

All tunnel and machine room floors have been painted with concrete floor paint. All machines have been gone over and where necessary refinished; all exterior steelwork has been touched up with red-lead paint and finished with Detroit graphite gray paint, and, in fact, whenever there has been deterioration of the paint a new coat has been applied.

## REGULATING VALVES.

Arrangements were made last year to purchase regulating valves for installation at the upper and lower ends of the center wall culverts at all locks. The work on the valves was started and completed as follows:

	Machine installed complete.	Valve installed complete.
Upper Pedro Miguel.....	Work started.	90 per cent complete.
Lower Pedro Miguel.....	June 1, 1916...	Apr. 1, 1916.
Upper Miraflores.....	Work started..	16 per cent complete.
Lower Miraflores.....	.....do.....	80 per cent complete.

Neither valves nor machines will be installed at Gatun, as they are believed to be unnecessary on the Atlantic side. The installation of the valves is being carried on as maintenance work; therefore rapid progress is not being made, as the lockages interfere with continuous work on the machines. In operating the valves it has been found necessary to install a 3 foot bulkhead to take care of the rise in water in the valve pits at the lower end due to the velocity of approach of the culvert discharge.

## REPAIR PITS.

In order to allow the repair of towing locomotives on either of the side walls or upon the middle level of the center wall, arrangements have been made to install repair pits, these being approximately 40 feet in length and 4 feet 6 inches in width, with adequate depth, so that the locomotives may be examined and repairs made to any portion of them. At Gatun the west and east wall of the repair pit, as well as the center wall pit, were completed on May 1. Repair pits at the Pacific locks are in process of construction.

## REPAIR SHOPS.

Arrangements were made to construct a repair shop at each of the locks, and during the last year arrangements have been made for the purchase of certain permanent equipment, which is listed as follows:

	Received.	Installed.
<i>Gatun.</i>		
20 inches by 12 feet lathe with motor drive.....	Jan. 16, 1916	February, 1916.
36-inch drill press with motor drive.....	Oct. 24, 1915	Do.
24-inch shaper with motor drive.....	Sept. 15, 1915	November, 1915.
14-inch sensitive drill with motor drive.....	July 21, 1915	January, 1916.
<i>Pedro Miguel.</i>		
36-inch drill press with motor drive.....	Oct. 24, 1915	December, 1915.
14-inch sensitive drill with motor drive.....	July 21, 1915	September, 1915.
<i>Miraflores.</i>		
20 inches by 12 feet lathe with motor drive.....	Jan. 16, 1916	February, 1916.
36-inch drill press with motor drive.....	Oct. 24, 1915	December, 1915.
24-inch shaper with motor drive.....	Sept. 15, 1915	September, 1915.
14-inch sensitive drill with motor drive.....	July 21, 1915	Do.



## SNUBBING BUTTONS.

The snubbing buttons and posts at all locks have been painted with one coat of red lead as protection against corrosion.

## SPARE PARTS.

During the past fiscal year a total of 48 United States requisitions were issued, and material complete had been received on 34 of them, the balance being in the process of manufacture and delivery.

## SPILLWAY CAISSONS.

The Gatun spillway caisson was painted and placed in the water in September, 1915.

The spillway caisson for Miraflores has been coated with bitumastic enamel, but will not be placed in the water until the completion of the contractor's work in the west chamber at the locks.

## SPILLWAY, MIRAFLORES.

The usual maintenance work has been done upon the spillway at Miraflores, and a lighting system has been installed, consisting of nine concrete lamp-posts along the top of the spillway structure, and 16 lights have been installed underneath the walkway, so as to adequately light the spillway gates at night.

## TURNOUTS.

Arrangements were made last year to purchase the necessary switch frogs and track for installing turnouts at all locks. The installation of these turnouts will allow the return tracks at all locks to be used, which was formerly impossible owing to the fact that damaged locomotives or cranes had to be placed upon the return tracks. The turnouts have now been installed and repair pits have been placed under the tracks in the back fill, as described above. The dates of completion of this work are as follows:

Turnouts for Gatun lower east level, April 1, 1916.

Turnouts for Gatun middle east level, April 1, 1916.

Turnouts for Gatun upper east level, April 1, 1916.

Turnouts for Gatun lower west level, April 1, 1916.

Turnouts for Gatun middle west level, April 1, 1916.

Turnouts for Gatun upper west level, April 1, 1916.

Turnout for Pedro Miguel, west, May 1, 1916.

Turnout for Pedro Miguel, east, May 1, 1916.

Turnout for Miraflores lower east level, June 1, 1916.

Turnout for Miraflores upper east level, started in June, 1916.

## TELEPHONES.

The telephone equipment at all locks has given satisfactory service throughout the year, except that it has been found advisable to remove all rubber-insulated double-braid wire and replace it with duplex, lead-covered, rubber-insulated cable. The installation of lead-covered cable has been carried on whenever men are available.

Pedro Miguel, lead-covered cable installed complete, July, 1915.

Miraflores, lead-covered cable installed complete, September, 1915.

Gongs have been installed on one of the lamp-posts above and below the control house on the center wall and are used for signalling the superintendent and foremen when they are wanted on the telephone.

#### TOWING LOCOMOTIVES.

During the year the towing locomotives have given excellent results in the handling of vessels of all sizes. Connecting the towing locomotive motors in concatenation, begun during the preceding fiscal year, was completed during this year, allowing for their operation at a speed of 1 mile per hour when desired.

The Signal Code and Rules for the Operation of Towing Locomotives were revised and reprinted during the year.

#### TRANSFORMER ROOMS.

During the year samples of oil have been removed from all transformers and oil switches, and if the dielectric strength of the oil was not satisfactory, arrangements were made to filter and replace the oil with dry material.

#### WHISTLES.

Electrically operated whistles have been installed at all lock-control houses for signalling the lock pilots and crews. The whistles may be operated by pressing any one of the several buttons located at frequent intervals along the edge of the control switchboard.

Further details of operation and maintenance of the locks are contained in the following extracts from reports of the lock superintendents.

#### GATUN LOCKS.

The work was under direct charge of Capt. T. H. Dillon, Corps of Engineers, United States Army, as superintendent, the entire year.

Capt. Earl J. Atkisson, Corps of Engineers, United States Army, was assigned to duty as assistant superintendent July 8, 1915, and since that time has been in charge of all field and maintenance work and was acting superintendent from May 4 to June 30 during the absence, on leave, of the superintendent.

Mr. T. W. McFarlane continued as mechanical supervisor until August 16, 1915, when he was transferred to the coaling plant at Cristobal. Mr. T. E. Heslin was promoted to fill the vacancy.

Mr. Ellis D. Stillwell continued as electrical supervisor throughout the year and acted as assistant superintendent from May 4 to June 30.

The organization has continued in much the same way as last year. Certain improvements have been made by placing general operators in direct permanent charge of tunnel and locomotive maintenance and in more direct personal responsibility for various work around the locks. All locomotive operators are trained by one man. Great improvement in this regard has been effected also by rigid oral and practical examinations before qualification.

A new system of property management has effected economy.

More system has also been applied to all maintenance work and definite instructions have been issued to insure more effective work. Fixed times have been set for inspections to prevent neglect of important matters.

The lock-pilots system, which was discontinued July 5, 1915, was renewed in April, 1916, with addition of placing lock pilots under direct orders of lock superintendents. The result is a fixed responsibility for safe operation and much more satisfactory work all around.

The silver force was increased while painting lock gates and overhauling machinery. While the canal was closed on account of slides the work at Gatun Locks was carried on by half force, the reduction being made by transfer and furlough.

In general, it may be stated that great improvement has been made during the year in smoothness of operation, more systematic and effective maintenance, and in better cooperation and more definitely fixed responsibility.

## LOCKAGE OPERATION.

Report of lockages follows:

Months.	Commer- cial.	Noncom- mercial.	Total.
July.....	146	13	159
August.....	120	7	127
September.....	98	15	113
October.....	36	42	78
November.....	0	17	17
December.....	8	12	20
January.....	7	9	16
February.....	5	19	24
March.....	7	25	32
April.....	65	21	86
May.....	10	25	135
June.....	110	12	122
Total for the year.....			929

The average amount of water taken from Gatun Lake per lockage was 4,311,000 cubic feet.

The average time of single lockages is 54 minutes, counting time when bow of vessel passes first chain to time when stern clears the last gates. The time interval between getting first line aboard until bow reaches chain is about 7 minutes. In general, when ships are ready, lockages follow each other at about 1 hour and 15 minute intervals. The best time made during the year was a succession of four down lockages at night in exactly four hours. Speed is sacrificed to safety of operation, effort being made to eliminate only unnecessary delay. There were only two delays of 30 minutes each to lockage operation during the year due to faulty operation of machines or men.

The largest ships locked through to date have been the *S. S. Kroonland* and the *S. S. Finland*, of the Panama-Pacific Line—length, 578 feet, beam 60 feet, draft generally about 30 feet.

The system of lockage operation continues as described in the last annual report, except that the locomotives are relied upon entirely to stop the ships in lock chambers without using ships' engines. This obviates danger of mistake in engine-room signals in the most precarious position of a lockage.

As before stated, the lock pilots who were removed early in the year were replaced. They are now detailed for several months' time at the locks, and being under the orders of the lock superintendents, constitute a part of the lock force. Better operation is thus secured through closer cooperation between pilots and locomotive operators, and the responsibility for everything that occurs during lockages is absolutely fixed in the lock superintendents.

Charging all expenses at Gatun Locks for July, August, and September, as shown on cost sheets, against lockages, except the contract cost of painting lock gates, the cost per commercial lockage for those three months was approximately \$216,425. The cost per net ton was approximately \$0.0485. The cost of painting gates was deducted on account of benefit being spread over a much longer period than these three months, the proper proportion being more than overbalanced by extra work done on overhauling machinery while locks were unwatered.

## OPERATING MACHINERY.

In addition to the ordinary work of inspection, lubrication, and general maintenance, practically every machine at Gatun Locks has been thoroughly overhauled during the year. Certain small difficulties and faults of operation have appeared, necessitating small changes and improvements, but, as stated in last report, the lock machinery is adequate for the purpose intended, the major principles involved being remarkably well provided for.

## EMERGENCY DAMS.

Each emergency dam has been operated once each month except when one chamber was out of service. One of these operations each month has been held after dark. Practically all men on the locks have been instructed and have qualified in operating gate and girder machines. The supervisors and general operators have been qualified to swing the dams. Typewritten instructions have been issued covering duties of all in case of emergency. Ordinary maintenance has been carried on through the year. All motors were taken out, cleaned, painted, and overhauled. Limit switches were placed on wedge-operating motors. Guides were installed for girder cables. Foot-friction brakes were placed on gate motors. Clutch solenoids were removed. Clutches on gate machines were readjusted and indicators placed for quickly lining up gears and changing clutches. Ventilating holes were placed in panel boxes; also new rubber gaskets. Lights were placed convenient to the No. 1 gates. Footboards were placed for operators and silver helpers during operation. Both dams were thoroughly inspected, rusty spots cleaned and painted.

## MISCELLANEOUS WORK.

There has been a general clean-up around locks and back fills and all unnecessary tracks removed. Permanent connections with the Panama Railroad and with tracks on Gatun Dam have been made. All temporary walks have been eliminated and permanent ones have been constructed.

Repairs have been made to deck and tunnel lights, bitumastic having been used around blocks and individual lights.

Timber fenders were extended on all walls to the first gates for protection to ships. Surface air and water pipes were removed and permanent connections installed in concrete boxes, all walls, all levels.

Window sash and frames on all locomotives were repaired.

Clean-up of property: Surplus and scrap material to the value of \$13,877.43 has been collected and turned in.

Pump barge *No. 169* and its machinery was repaired and placed in service for the unwatering of the locks and overhauling and painting of lock gates and machines.

All snubbing buttons which had broken away from the wall on account of settlement of back fill have been raised and painted.

Miscellaneous electrical work: Insulation resistance was taken on all motors on locomotives, emergency dams, rising-stem valves, cylindrical valves, miter gate machines, handrails, chain fenders, guard valves, auxiliary culvert valves, and cross-under sump pumps, 36 of these showing a resistance of 25,000 ohms or less, most trouble being experienced with handrail and sump pump motors. All were dried out and more systematic methods of inspection arranged; 100,000 ohms has been fixed as lowest standard.

The oil in all transformers and switches has been dried and cleaned, the majority being in very bad condition. Everything in connection with their rooms was thoroughly overhauled and placed in first-class condition.

Trouble in light and telephone chases, owing to deterioration of insulation caused by excessive dampness, has been lessened somewhat by opening holes for ventilation.

Lighting feeders Nos. 7 and 18 were turned over to the electrical division. Lighting busses were connected through to oil switches Nos. 2 and 3 in both switch-bank rooms. These switches were then permanently connected to the caisson feeders. Jumpers in these feeders have been removed, but held in the room ready for immediate use.

## SPECIAL.

Surges in locks: On account of overtravel of water in equalizing levels surges are set up in lock chambers of sufficient head to slam the gates. Studies of the periods of these surges have been made and a system of timing the closing of the gates in conjunction therewith has been worked out. The gates are now closed at such times as will bring the last position of the closing movement against the surge so that the slight water head prevents their slamming. The proper times are indicated by certain positions of the gauges on the control board. The average delay per lockage will not exceed 30 seconds.

Spilling through culverts direct from lake to sea: This was done through side-wall culverts on several occasions during the dry season while baffle piers at the spillway were being repaired. Spilling was accomplished with one valve open at intake and all other valves at full opening. With both intake valves wide open it was found that lower chain fender and guard gate rooms were flooded through disturbance of water in

forebay. With one intake valve open and the other valves at full opening throughout the length of the side-wall culverts the readings of the various gauges after equilibrium was reached were as follows:

Lake level.....	86.45
Vent, emergency dam.....	76.00
Upper level.....	55.50
Middle level.....	38.41
Lower level.....	22.37
Sea.....	2.60

Data were not consistent enough for complete analysis of currents flowing, but a close approximation gave 7,250 cubic feet per second per culvert, or a velocity of approximately 28.40 feet per second through the culverts.

The currents set up in the channel were noticeable in Cristobal and were sufficient to create difficulty in handling ships at the oil berth.

Earthquake tremors: There have been several slight tremors felt at Gatun Locks during the year with no indication of damage.

Signal code: The signals for towing locomotives and instructions for operation of towing locomotives were revised during the year.

Settlement of south approach wall: The south approach wall is still settling at an average rate of about 0.35 inch per month, but has not yet reached the point where repairs are considered necessary. Soundings have been taken on each side which indicate that about 15 to 20 feet of new material might be placed on the bottom of channel alongside. It is believed that the addition of this material would tend to balance the weight and prevent further settlement.

#### PACIFIC LOCKS.

Mr. F. C. Clark continued as superintendent until February 10, 1916, when his services terminated on account of resignation, and Mr. R. H. Whitehead, assistant superintendent, then assumed the duties of superintendent. Mr. W. R. Holloway, electrical supervisor, was appointed to the position of assistant superintendent, made vacant by the promotion of Mr. Whitehead. Mr. Holloway has been acting as superintendent since June 15, at which time Mr. Whitehead entered on leave.

Mr. George L. Viberg continued as mechanical supervisor, and has been acting assistant superintendent since June 15. Mr. George R. Welch was appointed electrical supervisor, effective February 10, 1916, his services terminating on account of resignation, effective at the close of business on June 15. This position has not yet been filled.

The general organization of the division was the same as for the last fiscal year. The size of the personnel has been increased by the addition of a number of locomotive operators, which subsequently necessitated an increase in the silver force. This increase applies to Miraflores Locks mainly, the force at Pedro Miguel remaining practically the same. This is explained by the fact that quite a large force is working on the special maintenance work being carried on at Miraflores.

The lock pilots have been placed in the lock organization and are now reporting to the lock superintendent. This system is working out very satisfactorily.

At the time the canal was closed on account of slides on September 18, 1915, there was enough construction and maintenance work to keep the force occupied for a period of about two months.

This work was nearing completion by the middle of November, 1915, and it was found necessary to reduce the force in some manner to relieve the situation. It was at first thought advisable to furlough the men, allowing about half the force to alternate on furloughs of two-week periods. A number of the men preferred to take their vacations rather than go on furlough, and as some of the men transferred to other divisions temporarily, the situation was soon well in hand. Very few men were actually furloughed. The silver force was considerably reduced at the time the canal was closed.

#### OPERATION.

As previously reported, the filling of the locks at Pedro Miguel sets up surges in the Cut, which may cause serious currents through the restricted channel of the slide. For this reason it has been the practice to draw water slowly after 11 a. m. and to draw no water while large ships are passing the slide. It has been found, however, that conditions can actually be improved by drawing water on the crest of the surge, thereby eliminating the reverse current that the static head at Pedro Miguel would normally set up. Of late advantage has been taken of this fact to draw water while ships are in the slide, thus both improving conditions in the Cut and effecting a saving of time at the locks.

The operating force has become very adept in the handling of lockages, and large ships are handled with the same ease as small ones.

During the year 987 operations were made at Pedro Miguel, 752 of which were for commercial vessels; at Miraflores 960 operations were made, 772 of which were for commercial vessels. These operations are segregated as follows:

	Pedro Miguel.			Miraflores.		
	Commercial.	Noncommercial.	Total.	Commercial.	Noncommercial.	Total.
July.....	164	18	182	164	17	181
August.....	141	14	155	149	13	162
September.....	99	7	106	108	7	115
October.....	3	14	17	3	15	18
November.....		9	9	1	13	14
December.....	8	9	17	8	15	23
January.....	7	12	19	7	12	19
February.....	5	42	47	5	25	30
March.....	7	44	51	7	18	25
April.....	71	32	103	72	17	89
May.....	126	20	146	126	25	151
June.....	121	14	135	122	11	133
Total.....	752	235	987	772	188	960

Number of commercial vessels:

	Pedro Miguel.	Miraflores.
July.....	170	170
August.....	155	155
September.....	107	109
October.....	3	3
November.....		1
December.....	10	9
January.....	19	19
February.....	5	5
March.....	8	8
April.....	76	76
May.....	129	129
June.....	125	125
Total.....	807	809

In addition to the above, six launches, paying tolls, were locked through Pedro Miguel, and five were locked through Miraflores.

The average time for making lockages at Pedro Miguel is 23 minutes, and at Miraflores is 40 minutes. It requires an average of 50 minutes per lockage at Miraflores at present, on account of the special maintenance work being carried on.

It has been necessary to close the lower guard gates at Pedro Miguel quite frequently, due to the fact that the military authorities use this as a means of communication from one side of the canal to the other.

#### WATER.

Last year's operations were marked by a steady decrease in the average amount of water used per lockage as the number of lockages increased. This year the average amount of water used per lockage at Pedro Miguel has been 2,941,000 cubic feet, as compared with 2,900,000 cubic feet in June, 1915. There has been no decrease in the average amount of water used per lockage at Miraflores.

#### TRAFFIC.

Although the traffic has increased more rapidly since the reopening of the canal on April 15, 1916, than it did following the initial opening, it has not as yet reached the value it had at the time the canal was closed on September 18, 1915.

## MAINTENANCE.

In the report for the previous fiscal year, mention was made that the valves and gates at Miraflores were cleaned and painted as a result of examinations made at the time the floating caisson was tested out. It was thought at that time that paint would be a sufficient protective coating to prolong the life of the submerged parts for a considerable time. The leakage at Miraflores increased to such an alarming extent that it was found that some other protective measure would have to be adopted. A contract was accordingly entered into with the American Bitumastic Enamels Co. to coat all the submerged parts at Miraflores with bitumastic solution and enamel, this same work being contemplated at Pedro Miguel after completion of the work at Miraflores.

## EMERGENCY DAMS.

The operators have been trained to a high degree of proficiency in the operation of the emergency dams. Operations are being performed regularly each month, requiring approximately 30 minutes at Pedro Miguel and 25 minutes at Miraflores for a complete operation, such operation not including the placing of drive pipes. The operations at Miraflores, of course, do not require as much time as at Pedro Miguel, owing to the fact that there are five gates at Pedro Miguel, while at Miraflores there are only four.

The operation of the dams has been facilitated and made safer by means of a device installed on all gate machines for aligning the clutches. By means of this arrangement the clutches can be changed from one gate to the next without resetting.

Arrow signals have also been installed whereby the silver men who hook and unhook the gates can signal to the operator when the hooks are clear or are in place. This device has been found to be of considerable advantage in making operations.

Limit switches have been installed on the wedge motors of the emergency dams to prevent overtravel.

A slight settlement of the backfill behind the east walls necessitated a readjustment of the rack quadrant of the east dams at both sets of locks. In settling, the quadrant had distorted from the true arc of a circle, and while this distortion was not sufficient to prevent operation of the dam, it was believed advisable to make the correction. It was also believed that no further adjustment would be required, as the west dams at both locks had shown no signs of settlement after they were first adjusted.

## MITER GATES.

A new design of grease cup has been installed for lubricating the miter gates, which has been found to be far superior to the original method. These cups are used for lubricating the vertical pin at the strut arm knuckle connection, as well as the pintle.

All the gates were painted above the water line by our forces, with two coats of red lead and one coat of No. 30 marine brown.

The interior compartments of all the gates were given a thorough inspection once each month.

## TRANSFORMER ROOMS.

The oil in all the oil switches was taken out and filtered, and the oil in all the transformers was tested and replaced where found to be in poor condition.

## CONTROL HOUSES.

The control houses at both sets of locks were given a complete painting on the interior, which made quite an improvement in their appearance.

## CHAIN FENDERS.

Interlocking relays were installed on the chain fender machines to prevent starting of the main pump before reversal of the Nelson valve and thereby avoiding high cylinder pressure. An operator has been detailed for duty in connection with caring for and adjusting the valves. All the relief valves at both locks were overhauled.

All the chain fender machines were maintained in a satisfactory manner, and the machines, as well as the chains, were given a complete painting.

## MESS HALLS.

It was found necessary to erect buildings at both Pedro Miguel and Miraflores so as to give the silver men a place to eat their lunches. They were otherwise required to make use of the tunnels or other shelter about the locks for this purpose. The new buildings provide a place for both gold and silver men.

## ELECTRICAL DIVISION.

The duties of the electrical division during the fiscal year comprised the operation and maintenance of all steam and hydroelectric power plants and of Balboa air compressor plant; all electrical transmission and distribution systems, and house and street lighting systems; the telephone, telegraph, and automatic railway signal system of the Panama Railroad; the design and construction of all extensions and additions to such systems; the installation, operation, maintenance, and repair of electrical apparatus of all kinds for other departments and divisions of The Panama Canal.

The hydroelectric station at Gatun, Miraflores steam-power plant, and the substations, high-tension transmission lines and distribution lines of the electrical division have operated satisfactorily during the year and without incident worthy of special mention. The old steam-generating station at Gatun was dismantled during the year, and the turbo generators, boilers, and other equipment installed in an extension of the Miraflores plant that was constructed during the year. This change will result in a reduction of operating expenses and in more effective maintenance of the equipment.

New 4,400 horsepower water wheels were ordered during the fiscal year for the main generating units at Gatun hydroelectric station which will result in increasing the capacity of the station by about 40 per cent. New cable feeders, oil switches, and other auxiliaries for taking care of this increased output have also been ordered, as well as two new 4,000 k.v.a., 44,000-volt transformers for Gatun substation.

The prospects of further heavy additions to the electrical load on the Canal Zone as listed in the report of the electrical engineer have made it desirable to arrange for still larger capacities of the hydroelectric station and Gatun substation. Appropriations for the coming fiscal year have been made and plans are in progress for building an extension to the hydroelectric station of the same size as the present building, adding three new penstocks and one new 4,500 k.w. generator unit. This will permit of an ultimate increase of the station capacity of 22,140 kilowatts at 80 per cent power factor. The large increase in generating capacity has made it advisable to change the voltage of the generating station from 2,300 to 6,600 volts to reduce the number and cost of the cable feeders between the hydroelectric station and Gatun substation. The increase in the hydroelectric station by the addition of the new generating unit will involve the addition of a new power transformer in Gatun substation, which will probably be of 11,000 k.v.a. capacity.

The average production cost of current at the hydroelectric station during the fiscal year was 0.06 cent per kilowatt hour, including all operation, maintenance, repair, and division overhead charges, but



not including depreciation. Including a charge of 3 per cent of the capital cost of the entire power system for functional depreciation, the cost of generated power at the hydroelectric station was 0.27 cent per kilowatt hour. As distributed from the substations, including the cost of operation and maintenance of the reserve steam plant at Miraflores, the substations, transmission lines, and distribution lines, and, including the depreciation charge, the cost of current for power purposes was 0.773 cent per kilowatt hour. The cost for lighting service, including the maintenance of house-lighting systems and lamp renewals, was 1.45 cents per kilowatt hour.

New cast-iron liner plates and floor plates were installed on the baffle piers at Gatun spillway during the fiscal year to prevent erosion of the concrete, and further protective work will have to be done during the present fiscal year.

The operation of the 13 electric cargo-handling cranes of the Panama Railroad on Balboa pier was conducted by the electrical division during the fiscal year. Seven hundred and twenty-five vessels were loaded or unloaded, with a total of 103 crane-hours delay.

The operation and maintenance of telephone, telegraph, and railway signal systems for the Panama Railroad was also conducted by the electrical division. One thousand eight hundred and seventy-eight telephones were in service on June 30, 1916, and during the last 6 months of the fiscal year there was an average of 15,165 telephone calls per day. Telephone troubles (except cable troubles) averaged 13 per day during the year and there was a total of 13 cases of cable trouble during the year on 468,268 feet of telephone cable. On the automatic block signal system of the Panama Railroad failures averaged one per 30,858 arm movements.

A large increase was observed during the fiscal year in the work of the armature winding and electrical repair shop. Five hundred and seventy-four repair jobs were turned out during the year, 90 of which involved the complete rewinding of rotors or stators or both.

A large amount of construction work was done on the construction of underground conduit lines and underground and overhead distribution lines and street and yard lighting systems. Motor-driven pumps were installed for Mount Hope Dry Dock. Two hydraulic graders for dredging division work on the slides were fitted up. The electrical equipment was installed in four berm cranes for Balboa coaling plant, and in the pumping and air compressor plant at Balboa Dry Dock. Light and power systems were designed and material purchased for Pier No. 7 at Cristobal and Pier No. 18 at Balboa, and most of the work on the latter pier completed. Three hundred and eighty-three house meters were installed during the fiscal year for The Panama Canal and for the Army. Designs and specifications were prepared and material purchased and installed for electrical installations in all new buildings constructed for The Panama Canal and for the Army during the fiscal year. A total of 3,828 work orders covering separate jobs were issued by the electrical division during the year, an average of 319 per month, for work outside of routine operation and maintenance.

The details of the operations of the electrical division during the fiscal year are covered in the report of the electrical engineer which follows:

#### ELECTRICAL DIVISION.

*Maj. W. H. Rose, Electrical Engineer.*

During the fiscal year the duties of the electrical division comprised the operation of all steam and hydroelectric power plants, Balboa air-compressor plant, electrical transmission and distribution systems for The Panama Canal; the design, construction, operation, and maintenance of permanent underground electrical distribution systems, street-lighting and house-lighting systems for The Panama Canal, Panama Railroad, Army and Navy; the operation and maintenance of the telephone, telegraph, and automatic railway-signal systems and of the electric cargo-handling cranes for the Panama Railroad; the installation, operation, maintenance, and repair of electrical apparatus of all kinds for other departments and divisions of The Panama Canal.

#### DIVISION OFFICE AND DESIGNING WORK.

The usual office work was done throughout the year in connection with miscellaneous correspondence, reports, power and compressed air accounting, and other routine papers. Plans were developed and specifications prepared for new water turbines of increased size (4,400 h.p.) for the three main generating units of the Gatun hydroelectric station, for four new cable feeders of 400,000 circular mil conductor area between the hydroelectric station and Gatun substation, for two new 4,000 k.v.a. power transformers for Gatun substation, and for new oil switches and other accessories for both the hydroelectric station and Gatun substation to provide for the increased equipment above named. The necessary plans, estimates, specifications, requisitions, etc., were prepared for extensions to underground conduit and cable distribution systems for electric light, power, telephone, street lighting, and fire alarm service in permanent towns and Army posts, for lighting and power systems in all new buildings for The Panama Canal, Panama Railroad, United States Army, and United States Navy, and for light and power systems in new Pier No. 18 at Balboa and new laundry at Ancon.

#### OPERATION OF POWER PLANTS.

*Hydroelectric station.*—The hydroelectric station at Gatun has been in continuous operation throughout the year as the primary source of power for all purposes in the entire Canal Zone. There have been no operating difficulties worthy of mention, and the operating characteristics of all machines and apparatus has been highly satisfactory throughout the year.

Due to the steady growth of the electrical load on the Isthmus, as discussed in the last annual report, the present capacity of the hydroelectric station is insufficient to meet the demand at all times, and during the fiscal year it has been regularly necessary to carry peak loads ranging up to 2,000 kilowatts and of several hours duration per day on the steam generating station at Miraflores. The plan of increasing the capacity of the hydroelectric station by the installation of new and higher capacity water turbines on the present generators was discussed in detail in the last annual report. The new water wheels have been on order since January 21, 1916, and delivery is now overdue by over a month, but is expected within the next few weeks. This change in the size of the turbines will result in increasing the capacity of each of the three units from 2,000 kilowatts to 2,880 kilowatts at 80 per cent power factor, an increase of approximately 40 per cent.

Even with this increase it now appears certain that the capacity of the hydroelectric station will again be exceeded in the near future by the addition of the following loads:

	Kilowatts.
Balboa Dry Dock pumps.....	14,500
Balboa Dry Dock light and power.....	150
Balboa coaling plant.....	750
Balboa town addition.....	150
Balboa submarine base.....	500
Ancon laundry.....	150
Ancon Hospital.....	225
Cristobal coaling plant.....	2,000
Cristobal cold-storage plant.....	300

<sup>1</sup> Intermittent.

	Kilowatts.
Cristobal town addition.....	50
New Pier No. 6.....	200
Stoves, water heaters, and other domestic appliances.....	1,500
Additional air compressor, Balboa.....	1,000
Pacific fortifications.....	225
Coco Solo submarine base.....	1,000
Additional Army quarters and storehouse.....	150
Total.....	12,845

The above loads are estimated only, but are believed to be low rather than high. Due to the effect of the load factor, the value of which can not be predicted, these loads will not produce a combined load on the system equal to the total of their separate values. The combined load, however, of these various increases will certainly be sufficient to raise the total demand on the Canal Zone beyond the capacity of the present generating equipment in the hydroelectric station even after the new wheels are installed.

For this reason funds were requested in the estimates for the fiscal year ending June 30, 1917, and have been appropriated for building an addition to the present station building large enough to provide for three additional generating units with their auxiliaries and for installing the first one of these three units. At the time the estimate was made it was intended that the new unit should be of the same size as the present ones with the new wheels, namely, 2,880 kilowatts at 80 per cent power factor. This would result in a station capacity of 11,520 kilowatts after the first new unit is installed and in an ultimate station capacity of 17,280 kilowatts. In case future developments on the Canal Zone increased the demand beyond this last amount, further increase at the hydroelectric station could only be secured at the expense of extraordinary difficulties and costs on account of the construction of the dam and spillway. Investigation has shown, however, that at slightly increased cost at the present time, and with only minor modifications in the interior design of the present station building, provision can be made for making all three of the new generating units of 4,500 kilowatts capacity, which will result in an ultimate station capacity of 22,140 kilowatts, instead of 17,280 kilowatts if present sizes are adhered to. Plans are therefore proceeding in the way of designs for penstocks, building, exciters, and other accessories on the assumption that the new unit to be purchased during the fiscal year 1917 will be of 4,500 kilowatts capacity at 80 per cent power factor, and that the two future units will be of the same size. The growth of the electrical load on the Isthmus has been so rapid and the experience of all electrical utility companies in the United States is so conclusive as to the certainty of continual growth that it is believed to be unquestionably the wisest policy to provide at the present time for the largest ultimate capacity that can be attained without radical and very expensive changes in the existing installation. The plan outlined above makes this provision.

Investigation has also shown that a very material saving in the ultimate cost of the power system can be effected if the new units are designed for generating at 6,600 volts instead of 2,200 volts, as in the case of the present units. The voltage of the present units will be stepped up to 6,600 volts by auto transformers to be installed between the generators and the station busses.

A typical load curve showing the combined load on both the hydroelectric station and Miraflores steam plant is shown on plate No. 68. The lower curve shows the average combined load at each hour of the day for the seven working days, June 23, 24, 26, 27, 28, 29, and 30. The upper curve shows the maximum combined load at each hour for the same seven days.

The production cost of current delivered from the switchboard of the hydroelectric station during the fiscal year was 0.06 cents per kilowatt hour. This cost includes all operation, maintenance, and division overhead charges, but does not include a charge of 3 per cent per annum of the capital cost of the entire power system that is being charged into our monthly accounts against the cost of power to cover functional depreciation. For convenience in accounting the depreciation of the entire system, including transmission lines, substations, and distribution systems, is charged into the cost of power at the generating station. If this depreciation charge be included, the cost of power at the hydroelectric station for the fiscal year was 0.27 cents per kilowatt hour.

The operation and maintenance of Gatun spillway was conducted during the year by the hydroelectric station force. All baffle piers were repaired during the last dry season, marked erosion of these piers having been noted in last year's annual report. Two additional cast-iron face plates were installed on each pier to protect the faces on

which erosion was most marked, and floor plates were installed to prevent further attack in the angle between pier and floor. The changes have made some improvement in conditions, but do not yet afford the desired degree of protection, and further work will have to be done during the next dry season.

*Miraflores steam station.*—This station has been operated as a reserve plant during the fiscal year, several boilers being kept under steam and up to pressure at all times, so as to minimize the length of interruptions in the case of failures at the hydroelectric station or on the transmission line. It has also regularly assisted the hydroelectric station by carrying peak loads whenever the total load was greater than the capacity of the latter plant. One or two of the 1,500 k.v.a. turbo generators have been kept "floating" on the line at all times in order to improve the regulation of the transmission line by improving the power factor by operation as synchronous condensers, and in order to be in immediate readiness for service in case of emergencies.

The amount of power absorbed by the plant in the operation of generators as synchronous converters, excitation, lighting, etc., has actually exceeded the power output during the year, so that no costs for generated power can be given.

The addition to the station building mentioned in last year's report for enabling the remaining equipment to be transferred from the Gatun steam station was completed during the year at a cost of \$47,268.90. All equipment has been removed from the Gatun plant and the old power plant building taken down. The work of reinstalling the equipment in the extension at Miraflores and of making the electrical changes necessitated by the extension was approximately 90 per cent completed at the close of the fiscal year, and the cost of removing from Gatun, reerecting at Miraflores, and making necessary electrical changes was \$33,703.81 up to June 30, 1916. The following tabulation shows monthly net outputs during the fiscal year from the hydroelectric station and Miraflores steam station, monthly costs of generated power, not including depreciation, power actually distributed to consumers, and per cent loss of power in transformation, transmission, and distribution:

Month.	Kilowatt hours.		Cost of generation, cents per k.w.h.		Total generated power.	Total delivered to consumers.	Per cent loss in transformation, transmission, and distribution.
	Gatun hydro-station.	Miraflores steam station.	Hydro-station only.	Including Miraflores.			
1915.							
July.....	2,957,000	23,000	0.06	0.20	2,980,000	2,522,195	19.0
August.....	3,185,680	14,480	.07	.18	3,200,160	2,688,143	19.3
September.....	3,209,680	—23,250	.06	.17	3,184,430	2,721,078	17.1
October.....	3,391,130	—17,130	.06	.18	3,374,000	2,805,006	20.3
November.....	3,252,142	—79,870	.07	.20	3,172,272	2,044,683	20.0
December.....	3,345,410	—80,030	.06	.19	3,265,380	2,663,697	20.6
1916.							
January.....	3,261,000	—81,220	.06	.18	3,179,880	2,673,071	18.2
February.....	3,211,690	27,000	.06	.17	3,238,690	2,652,649	22.1
March.....	4,001,200	53,470	.05	.12	4,054,670	3,521,572	15.1
April.....	3,438,300	—41,970	.06	.19	3,396,330	2,896,148	17.3
May.....	3,757,050	43,890	.06	.18	3,800,940	3,317,344	14.6
June.....	3,526,160	87,490	.06	.16	3,614,450	3,086,175	17.1
Average for the year.....			.06	.17			

#### AIR-COMPRESSOR PLANT.

The steam-driven air-compressor plant was operated during the fiscal year until April 18, 1916, for the supply of compressed air for Balboa shops, dry-dock and terminal construction, Sosa Hill quarry, and other purposes. On this date the plant was shut down and immediately dismantled.

The following tabulation shows the monthly output of this plant, in cubic feet, of free air compressed to 105 pounds per square inch:

	Cubic feet.
1915.	
July.....	157,805,925
August.....	169,328,705
September.....	156,993,290
October.....	173,676,645

	Cubic feet.
November.....	167, 085, 734
December.....	166, 036, 151
1916.	
January.....	161, 436, 446
February.....	217, 634, 881
March.....	267, 303, 822
April.....	<sup>1</sup> 65, 474, 690

<sup>1</sup> Plant closed Apr. 18, 1916.

#### OPERATION OF SUBSTATIONS AND TRANSMISSION LINES.

All substations operated throughout the year in the most satisfactory manner, and there were no interruptions of high-tension service due to failure or improper operation of substation apparatus during the year.

The increase in the size of the water wheels in Gatun hydroelectric station requires an increase in transformer capacity in Gatun substation and an increase in feeder capacity between the hydroelectric station and the substation. Accordingly two new transformers of 4,000 k.v.a. capacity each have been ordered and delivery is expected in September of the present year. These transformers will be arranged for low-tension voltages of either 2,200 or 6,600 volts, to provide for the contemplated change in voltage at the hydroelectric station previously discussed. Four new 400,000 circular mil feeder cables have also been installed, with the exception of a few splices and end bells, to provide for the required increase in feeder capacity. The necessary oil switches and other auxiliaries for generators, transformers, and feeders have also been ordered and delivery is expected within the next few weeks. The cost of the 4,000 k.v.a. transformers will be \$19,525 each. The cost of the new feeder cables has been \$33,039.50 for material alone, and the cost of labor, superintendence, and miscellaneous supplies for installation up to June 30, 1916, has been \$3,337.06.

The operation of low-tension (2,200 volts) transmission and distribution lines throughout the fiscal year has been highly satisfactory. There has been only one case of cable trouble on the entire underground system during the fiscal year, a cable burnout on a 4/0 feeder between the hydroelectric station and Gatun substation, that was evidently due to overheating of the cable by overload. Two 4/0 feeders were transferred from Gatun Locks to the transmission system in order to eliminate the overload condition, giving a total of 10 instead of 8 transmission cables between these two points.

The operation of the 44,000-volt transmission lines has also been satisfactory during the year. On the aggregate length of approximately 90 miles of high-voltage lines there have been a total of 33 interruptions of service, 19 of which were caused by insulator failures, one to failure of bushing of current transformer at Darien substation, one to failure of hydroelectric station feeder cable, one to a locomotive crane fouling the line, one to an animal attempting to crawl over a strain insulator, and 10 to unknown causes, probably insulator flashing over. The distribution of the insulator failures, by months, was as follows: January, February, March, May, June, and July, each one failure; April, August, October, and December, each two failures; September five failures and November none. Plate No. 69 shows the causes of all power interruptions and their distribution, by months.

There were 10 cases of the ground wire breaking during the fiscal year in comparison with 13 cases during the preceding fiscal year.

It will be noted that the majority of interruptions of service on the high-tension transmission lines, 19 out of 33, were caused by insulator failures. On account of this fact considerable attention has been paid to the insulator question during the past year. Conditions on the Canal Zone are rather unfavorable to insulator performance on account of extremely heavy rainfall, prevalence of fogs in certain localities, and location of transmission lines on track span bridges spanning the Panama Railroad tracks, which result in an accumulation of a greasy, sooty deposit from the smoke of passing locomotives on the surfaces of the insulator disks.

In the 19 interruptions of service caused by insulator failures, 20 disks were involved. In addition to these, 6 disks failed while lightning arresters were being charged and one while a test voltage 15 per cent above normal was being applied to the line. This makes a total of 27 insulator failures during the fiscal year. Plate No. 70 shows the location and dates of insulator failures from December, 1914, when the transmission line was first put into service, until June 30, 1916. It will be noted that out of 43 failures on 46 miles of duplicate transmission line, 24 occurred in the two 5-mile sections between miles 5 and 10 and between miles 30 and 35, and equal number, 12,

occurring in each of these sections. In other words, 56 per cent of the insulator failures occurred on a length of line representing only 22 per cent of the total line length. The section between miles 5 and 10, lying between Gatun and Monte Lirio is in the region where the railroad passes over wide arms of Gatun Lake on high earth fills. It is possible that extremely high humidity is primarily responsible for the excessive number of failures in this district, and the vibration of the insulators caused by passing trains may be a contributory cause by cracking the glaze or the porcelain body itself. The district between miles 30 and 35, which lies between Gamboa and New Culebra is a district of heavy and frequent fogs. The record of fogs for the year 1910, as published in the paper on "The Climatology and Hydrology of The Panama Canal" by Mr. F. D. Willson, chief hydrographer, presented at a meeting of the International Engineering Congress at San Francisco, 1915, shows fog occurrences during the year 1910 as follows:

Location.	Number of fogs.	Total duration. <i>Hrs. Min.</i>
Cristobal.....	6	25 10
Gatun.....	103	324 7
Bohio.....	217	1,210 30
Bas Obispo.....	201	893 25
Culebra.....	197	1,108 20
Pedro Miguel.....	130	471 25
Ancon.....	8	21 0

Bohio is near Monte Lirio, Bas Obispo is just opposite Gamboa, and Culebra is opposite New Culebra. It will be noticed that the greater frequency of insulator failures corresponds generally with the frequency of fogs. There were only two insulator failures in the five miles of line nearest Cristobal, and no failures at all between Pedro Miguel and Ancon.

Observations have also been taken from time to time of the insulation resistance of the line by means of a megger. Immediately after construction the insulation resistance between each 46-mile length of conductor and ground was 148 to 150 megohms. In about 14 months' time these values gradually lowered to values ranging from 250,000 ohms to 20,000 ohms. No material change has taken place since the first 14 months. The insulation resistance will change in a few hours' time from 250,000 to 20,000 ohms with changing weather and temperature conditions, as shown by Plate No. 71. These changes are undoubtedly due to changing surface conditions of the insulators and to more or less porosity of the porcelain.

The effect of the smoky deposit from the oil-burning locomotives of the Panama Railroad is shown by the reduction of flash-over values which varies from 80,000 to 85,000 volts at 25 cycles for clean insulator disks, and from 50 to 60 per cent of these values for sooty disks. If the soot is removed by gasoline the flash-over value is increased to normal.

The testing of the insulators in service by means of high resistance wireless receivers for the purpose of detecting defective insulators before failure occurs has been carried on during the fiscal year. Sixty insulator strings of three disks each that appeared to be unusually noisy in the receiver test were removed and tested by flashing over. Two strings were apparently normal. Five strings were found to have two punctured disks each, 15 strings had one punctured disk each, and all of the remaining 149 disks flashed over at voltage of from 50 to 60 per cent of normal. When cleaned of soot by means of gasoline, normal-flash over voltages were obtained.

The cost of producing power at the hydroelectric station has already been given. The following tabulation shows costs from month to month of distributed power and power for lighting including lamp renewals:

Table showing costs of distributed power and power for lighting, including lamp renewals.

Date.	Net consumption, k.w. hours.	Cost of operation and maintenance of hydro station.	Cost per k.w.h.	Cost of maintenance, Gatun steam plant.	Cost per k.w.h.	Cost of operation and maintenance, Miraflores steam plant.	Cost per k.w.h.	Cost of operation and maintenance, all sub-stations.	Cost per k.w.h.	Cost of maintenance, transmission lines.	Cost per k.w.h.
<b>1915.</b>											
July.....	2,522,165	\$2,076.41	\$0.000823	\$449.40	\$0.000178	\$3,794.30	\$0.001504	\$3,818.60	\$0.001514	\$2,001.23	\$0.000793
August.....	2,683,143	2,299.33	.000842	311.59	.000116	3,239.04	.001207	5,389.16	.002009	1,858.62	.000692
September.....	2,721,078	2,165.01	.000796	174.82	.000064	3,282.19	.001206	4,563.81	.001677	1,858.28	.000680
October.....	2,805,006	1,876.20	.000669	158.17	.000056	3,936.82	.001411	4,008.35	.001429	2,004.60	.000715
November.....	2,644,683	2,140.93	.000810	167.14	.000063	3,963.31	.001499	3,791.41	.001434	2,307.11	.000872
December.....	2,663,697	2,027.61	.000761	167.99	.000063	3,816.03	.001433	3,945.16	.001481	1,421.50	.000534
<b>1916.</b>											
January.....	2,673,071	1,933.58	.000731	86.31	.000032	3,747.45	.001402	3,750.91	.001403	1,710.88	.000540
February.....	2,652,649	1,985.02	.000748	89.91	.000034	3,370.14	.001270	3,000.85	.001380	1,654.61	.000524
March.....	3,521,572	1,944.82	.000552	.....	.....	3,096.39	.000822	3,743.78	.001063	1,894.33	.000538
April.....	2,896,148	2,080.00	.000718	.....	.....	4,366.88	.001566	4,229.34	.001460	1,913.05	.000661
May.....	3,317,344	2,470.00	.000745	.....	.....	4,283.81	.001291	4,037.70	.001217	2,407.53	.000726
June.....	3,086,175	2,103.23	.000832	.....	.....	3,667.72	.001188	3,743.70	.001213	1,460.26	.000454
	34,186,761	25,082.14	.000734	1,695.33	.000047	44,663.78	.001306	48,082.77	.001424	22,424.00	.000556

Table showing costs of distributed power and power for lighting, including lamp renewals—Continued.

Date.	Cost of maintenance, distribution lines.	Cost per k.w.h.	Depreciation of transmission system.	Cost per k.w.h.	Total cost of current for power distributed.	Cost per k.w.h.	Net consumption lighting current, k.w. h.	Cost of maintenance, lighting system.	Cost per k.w.h.	Total cost of lighting current per k.w.h.
1915.										
July.....	\$3,098.57	\$0.001216	\$8,000.00	\$0.003172	\$23,208.51	\$0.002900	611,769	\$3,357.93	\$0.005489	\$0.014689
August.....	1,630.03	.000611	8,000.00	.002982	22,636.77	.008160	490,753	3,032.84	.006221	.014681
September.....	1,655.21	.000395	8,000.00	.002942	21,111.32	.007760	543,830	3,315.53	.006997	.013877
October.....	2,657.72	.000905	8,000.00	.002852	20,399.86	.007226	518,185	3,551.08	.006859	.014085
November.....	2,177.53	.000825	8,000.00	.003025	22,547.43	.008526	547,510	3,259.92	.003954	.014480
December.....	3,062.35	.001150	8,000.00	.003063	22,440.64	.008425	546,444	3,886.78	.007113	.015338
1916.										
January.....	2,327.83	.000871	8,000.00	.002963	21,576.96	.008072	538,941	3,964.76	.007093	.015165
February.....	2,282.32	.000860	8,000.00	.003016	21,042.85	.007332	452,510	2,893.36	.006394	.013296
March.....	2,568.17	.000729	8,000.00	.002772	21,157.49	.006016	599,076	3,844.74	.007552	.013568
April.....	2,595.66	.000896	8,000.00	.003762	23,324.63	.008053	596,837	4,283.59	.008152	.016505
May.....	2,618.07	.000798	8,000.00	.003112	23,847.11	.007189	573,376	3,912.05	.006823	.014012
June.....	2,088.71	.000677	8,000.00	.002592	21,003.62	.006896	582,875	4,430.41	.007601	.014407
Total.....	25,799.17	.000755	96,000.00	.002808	264,257.19	.007730	6,442,106	43,755.89	.006792	.014722



	Totals for fiscal year 1915-16.	Average per month.	Average cost per k.w.h.
Net consumption, kilowatt hours.....	34,186.761	2,848.897	-----
Cost of operation and maintenance, hydroelectric station.....	\$25,082.14	\$2,090.18	\$0.000734
Cost of maintenance, Gatun steam plant.....	1,605.33	133.78	.000047
Cost of operation and maintenance, Miraflores steam plant.....	44,663.78	3,721.98	.001306
Cost of operation and maintenance, all substations.....	48,682.77	4,056.90	.001424
Cost of maintenance, transmission lines.....	22,424.00	1,868.67	.000656
Cost of maintenance, distribution lines.....	25,799.17	2,149.93	.000755
Depreciation, transmission system.....	96,000.00	8,000.00	.002808
Total cost of current for power distributed.....	204,257.19	22,021.43	.007730
Net consumption, lighting current, k.w.h.....	6,442,106	536,842	-----
Cost of maintenance, house-lighting systems.....	\$43,755.89	\$3,646.32	.006792

## OPERATION OF BALBOA CARGO-HANDLING CRANES.

The electrical division performed all work in connection with the operation and maintenance of the 13 electric cargo-handling cranes of the Panama Railroad on Balboa Dock. The following tabulation shows monthly performances:

Month.	Ships loaded.	Ships un- loaded.	Lighters loaded.	Light- ers un- loaded.	Crane- hours worked.	Crane- hours delay.
1915.						
July.....	11	13	18	13	2,103	14
August.....	14	7	10	7	1,730	10
September.....	7	6	8	11	1,257	6½
October.....	9	14	8	27	3,400	15½
November.....	14	14	13	45	4,590	13½
December.....	10	11	22	30	3,221	6½
1916.						
January.....	12	16	20	33	3,847	8½
February.....	15	12	29	32	3,067	5
March.....	12	15	16	55	4,350	13½
April.....	11	9	17	30	2,485	6
May.....	8	-----	5	23	394	4
June.....	1	4	2	6	260	-----
Total.....	124	121	168	312	30,764	103

A total of 292 vessels were loaded and 433 unloaded during the fiscal year. Of the 103 crane-hours' delay for the entire year, 32 crane-hours were caused by rain. All cranes were painted during the year, had their electrical systems overhauled, and the 8 alternating-current cranes were modified so as to reduce the trolley speed from 600 to 300 feet per minute. New trolleys and collecting devices were installed for all cranes.

## OPERATION OF TELEPHONE AND TELEGRAPH SYSTEM.

The electrical division did all work in connection with the operation and maintenance of the telephone and telegraph system of the Panama Railroad during the fiscal year.

Four hundred and twenty-two telephones were installed during the fiscal year and 284 were removed, leaving 1,878 in service on June 30, 1916. During the last six months of the fiscal year there was an average of 15,165 telephone calls per diem as determined by peg counts taken on one day each month. The average number of telephone troubles, including cases on all classes of subscribers' instruments and all wire troubles except cables, was 13 per diem, in comparison with about 30 cases per diem for the last fiscal year. The improvement is due to more regular and systematic inspections and to the decreased number of long twisted pair loops that has resulted from the construction of the new underground telephone distribution system.

Forty-four thousand nine hundred and forty-four feet of telephone cable of all sizes were installed, and 16,177 feet were removed during the fiscal year, leaving 468,268 feet in service at the end of the fiscal year. On this entire length of cable there were 13 cases of trouble during the fiscal year. One case on the trans-Isthmian cable due to malicious cutting of the cable by unknown parties and 12 cases on local cables. Of

these, 2 cases were due to rats gnawing through the sheath, one to the lead boring bug, three to leaky sleeves, and six to unknown causes.

Switchboard troubles have been less frequent than during the preceding fiscal year on account of the installation of new relay coils with better insulation.

Connections were made during the fiscal year to private branch exchange boards installed by the Signal Corps, United States Army at Fort Sherman, Fort Randolph, Gatun, Corozal, Quarry Heights, Fort Grant, Camp Otis, Camp Empire, and Camp Gaillard. New P.B.X. boards were installed and connected up for the port captain's office at Colon, the depot commissary at Cristobal, the receiving and forwarding agent at Colon, and for the Pacific terminals office building at Balboa. The old central office at Empire was abandoned and the telephone distribution system in the Empire district removed.

#### OPERATION OF RAILWAY SIGNAL SYSTEM AND ACCESSORIES.

The electrical division performed all work in connection with the operation and maintenance of the automatic block railway signal system, interlocking plants, etc., of the Panama Railroad during the fiscal year. At the end of the year there were 111 automatic, 14 semiautomatic, 22 power-operated, and 13 train-order signals in service. There were 7 interlocking plants in service with 142 active levers operating 10 power-operated, manually controlled, 13 semiautomatic, 4 high mechanical, wire-connected, 29 dwarf mechanical, with connected signals, 27 switches, and 32 derails.

There were no false clear signal aspects during the fiscal year and but one false caution aspect. There was a total of 2,922,449 arm movements with 199 responsible interruptions, 43 nonresponsible interruptions, and 721 train minutes' delay for the entire year. There was an average of one signal failure per 14,685 arm movements during the fiscal year. For the last six months of the fiscal year the average was one failure per 30,858 arm movements. During the preceding fiscal year there was one failure per 10,228 arm movements. Plate No. 72 shows the occurrence of responsible failures during the year, and Plate No. 73 shows the occurrence of train delays due to signal failures.

#### NORTHERN AND SOUTHERN DISTRICTS.

The usual operation and maintenance work was done in the Northern District during the year in connection with underground and overhead light and power distribution systems, house and street lighting systems, fire-alarm systems, and maintenance of electrical equipment for other departments and divisions of The Panama Canal, the Panama Railroad, and the Army and Navy in the towns of Colon, Cristobal, Mount Hope, Gatun, and surrounding districts. Similar work in the Southern District covered the towns of Gamboa, Camp Otis, Camp Empire, Camp Gaillard, Paraiso, Pedro Miguel, Corozal, Balboa, Ancon, La Boca, Fort Grant, and surrounding territory.

#### ARMATURE WINDING AND ELECTRICAL REPAIR SHOP.

Electrical repair work on all classes of apparatus for all departments and divisions of The Panama Canal, Panama Railroad, Army, Navy, and for commercial companies, steamship lines, etc., has been done during the fiscal year in the electrical division shop. The work of this class has been growing rapidly with increasing equipment going into service for The Panama Canal, aging of equipment previously installed, increasing demands by the Army and Navy, and increasing traffic through the canal. The shop force has been doubled during the fiscal year to meet this increase of work. Substantial savings to the Government have been effected by building coils for rewinding motors and generators instead of purchasing built-up coils from the manufacturers and in fabricating switch and panel boards of special design for various installations on the Isthmus. Many of the repair jobs undertaken required sending men out from the shop to do the work in the field.

During the year a total of 574 repair jobs of various magnitudes were completed, of which 90 involved the complete rewinding of motor or generator armatures or stators, or both.

A new lathe and drill press were added to the shop equipment during the year.

#### GENERAL ELECTRICAL CONSTRUCTION WORK.

*Power plants, substations, and transmission lines.*—Mention has already been made of the work done during the fiscal year in connection with the extension of the Miraflores power plant building, of the transfer of the steam-generating equipment from the Gatun plant to Miraflores, of the four new cable feeders that have been installed

between the hydroelectric station and Gatun substation, and of the repairs to the baffle piers at Gatun spillway.

*Underground conduit lines and underground and overhead distribution lines.*—Underground conduit systems containing from 4 to 8 ducts for the distribution of electric light and power, telephone and fire-alarm cables were constructed during the fiscal year for the new Army post at Fort Randolph, for piers Nos. 14, 15, 16, 17, and 18 at Balboa terminals from a point near the Balboa pumping station of the municipal division to a point near the Tivoli Hotel for the new Ancon laundry, printing plant, and other new buildings in the vicinity, and from the Administration Building to the new Balboa townsite, at a total cost of \$34,370.22. These conduit lines aggregated 15,450 feet in length and involved the construction of 68 concrete manholes and pull holes. Numerous other minor extensions to existing conduit systems in various localities were made to provide for new facilities of The Panama Canal.

For the Army authorities a subterranean and submarine transmission line was installed from Gatun hydroelectric station to Fort Sherman at Toro Point for transmitting current for post and fortification lighting and power at 6,600 volts. It involved the installation of three 100-k.v.a. 2,200/6,600 volt transformers in the hydroelectric station, of three similar transformers at Toro Point, of 7,200 feet of lead-covered cable, and of 40,900 feet of lead covered and armored cable at a total cost of \$44,514.22.

Five 300,000 circular mil 2,200-volt feeder cables aggregating 12,225 feet in length were installed between Balboa substation and the new dry dock pumping and air compressor plant at a total cost of \$14,952.20.

Two No. 4/0 2,200-volt feeder cables aggregating 10,760 feet in length were installed between Balboa substation and the new Balboa coaling plant at a total cost of \$7,636.07.

Five 300,000 circular mil 2,200-volt feeder cables aggregating 10,110 feet in length were installed between Cristobal substation and Cristobal coaling plant, at a total cost of \$15,671.18.

An underground distribution system for electric light and power and telephone service was installed for the Army at Fort Randolph at a total cost, including the street-lighting system, of \$15,071.86.

A rearrangement of the Balboa shops feeder cables so as to form a ring system and reduce the total amount of cable required was completed during the fiscal year.

There were constructed in the Culebra district 2,200 and 11,000 volt overhead-distribution lines aggregating 20,000 feet in length, for the supply of power to grader barges of the dredging division working on the slides. The total cost of these lines was \$7,287.18.

Numerous other minor installations of underground cables and overhead lines were constructed during the fiscal year to provide for new buildings and other facilities of The Panama Canal.

*Street lighting.*—New series street-lighting systems of the type described in the last annual report were constructed for the Army at Forts Grant and Randolph, and various extensions in the street-lighting systems of the Panama Canal towns were made to provide for new streets and buildings.

*Motorizing Mount Hope Dry Dock pumps.*—Motor-driven pumps, to replace the old steam-driven pumps at Mount Hope Dry Dock were installed for the mechanical division during the fiscal year.

*Grader barges for dredging division.*—The electrical installation for two grader barges for the dredging division for work on the slides in Gaillard Cut was made during the fiscal year involving the installation of one 300-horsepower and two 350-horsepower motor-driven pumps.

*Berm cranes.*—The electrical installation of the four berm cranes from Miraflores which are to be used in the new Balboa coaling plant was completed during the fiscal year at a total cost of \$15,326.

*Shop yard lighting system.*—The construction of a yard lighting system for Balboa shops, yards, dry dock, and vicinity was begun during the fiscal year and advanced to about 75 per cent of completion. The cost to June 30, 1916, was \$7,887.50.

*Balboa Dry Dock pumping and air-compressor plant.*—All electrical work in the construction of this plant, including the installation of four 1,000-horsepower motor-driven main pumps, two 200-horsepower motor-driven drainage pumps, one sump pump, one pressure pump, one 1,000-horsepower motor-driven air compressor, one 500-horsepower motor-driven air compressor, one 21-panel switchboard, 47 feet 6 inches in length, valve control bench board, miter gate control panel, building, and pump well lighting, etc., was performed by the electrical division during the fiscal year. Distribution cables and switchboard panels have been installed for the exterior lighting and power system of the dry dock.

*New piers.*—The electric power and lighting system for Piers No. 7, Cristobal, and 18, Balboa, were designed, material purchased, and partially installed during the fiscal

year. On Pier No. 18 the lighting has been finished and the power system for electric cargo-handling cranes and winches and coal conveyors has been completed with the exception of installing the power wire and cables and a motor generator set. This material has not yet been received on the Isthmus. The cost to June 30, 1916, of the electrical work on Pier No. 18 was \$14,802.38. The electrical work on Pier No. 7, Cristobal, was approximately 20 per cent completed at the close of the fiscal year. Extensive revisions in the power systems of Piers No. 8, 9, and 10, Cristobal, were made during the fiscal year to provide for electric cargo-handling winches and coal conveyors. The maintenance of electric storage-battery trucks for cargo transfer on the Cristobal piers was handled by the electrical division for the Panama Railroad during the fiscal year, and a battery charging panel with capacity for 16 trucks was installed on Pier No. 11.

*Installation of electric meters.*—The electrical division has installed 268 house meters, two and three wire, ranging in size from 5 to 25 amperes, for the Army, and 115 for The Panama Canal.

*Electrical installation work in buildings.*—Designs and specifications were prepared and material purchased and installed for all buildings constructed by the building division during the fiscal year for The Panama Canal and for the Army (see report of resident engineer, building division), a total of 64 concrete and 146 frame buildings.

*Miscellaneous.*—In addition to the principal items mentioned above a large amount of miscellaneous electrical construction work for various departments and divisions of The Panama Canal, Panama Railroad, Army, Navy, and individuals and companies was done during the fiscal year. The amount of this work can be judged from the fact that during the year 3,828 work orders, covering separate jobs, were issued by the electrical division. This is an average of 319 per month. During the first six months of the fiscal year the average was 268 per month, and during the last six months, 352 per month. Work orders are issued only in the case of special jobs requiring separate accounting and not issued for routine operation and maintenance work.

### MUNICIPAL DIVISION.

The organization of the municipal division remained unchanged, and the work accomplished by the division during the year included the maintenance and repair of the municipal improvements in the Canal Zone and in the cities of Panama and Colon and the operation of the pumping stations and the water purification plants, in addition to a large amount of construction work for that division and for other divisions and departments, which is described at length in the report of the municipal engineer.

The municipal division has charge of all water-supply systems on the Canal Zone, including the operation of the water-purification plants, and attention is invited to the report of physiologist George C. Bunker on the operation of the purification plants and the work of the laboratories connected therewith, giving the results of the investigations of tropical waters during the past year carried on by him and under his direction. This report will be found included in the report of the municipal engineer. Practically all of the water supply for the Isthmus, with the exception of that for the three military posts on the west side of the canal, is furnished by three water-supply systems. The water for all points north of Gatun, with the exception of Toro Point, is furnished by the Mount Hope plant, which includes the pumping station and the water-purification plant located at Mount Hope. The water is taken from the Brazos Brook Reservoir and consists of the water accumulated from the watershed of the reservoir supplemented as required by water obtained from Gatun Lake through a 20-inch pipe line laid in a tunnel 6 feet by 6 feet in section, leaving the lake at elevation plus 75. The water is purified in the Mount Hope purification plant and forced by pumps at this station through the distribution system supplying Mount Hope and all points

north. The average amount of water handled at this station during the year was 131,232,000 gallons per month. The water for Gatun and Gatun Locks is furnished by the plant located at Agua Clara and is obtained from the Agua Clara Reservoir and purified in the filtration plant located near the reservoir and forced by pumps at this station through the distribution system supplying Gatun and the locks, and also to a 300,000-gallon concrete reservoir located  $1\frac{1}{2}$  miles east of Gatun which acts as a surge tank. The average amount of water handled at this station during the year was 22,580 gallons per month. The water for Paraiso and for all points south, including Panama City, is furnished by the Miraflores plant, which includes the pumping stations at Gamboa, Miraflores, and Balboa, and the purification plant at Miraflores, together with the distribution systems and reservoirs. The water is obtained from the Chagres River at Gamboa and is pumped from there to Miraflores, from which point, after purification, it is supplied to all points south of Paraiso and east of the canal. The total quantity of water handled by this system during the year amounted to an average of 248,963,000 gallons per month.

The municipal division also has charge of the water-supply systems for the troops on the west side of the canal, the water at these posts being obtained from the Rio Grande and the Comacho Reservoirs and being pumped through the distribution systems that supply the posts. Small pumping plants are also operated at Monte Lirio and at Frijoles to furnish water for the settlements at those points.

The maintenance of the roads and streets and sidewalks in the Canal Zone and of the streets in the cities of Panama and Colon is also a part of the work of the municipal division. The work in the cities of Panama and Colon is performed for the Panaman Government, and the expense is repaid from the water rentals collected in those two cities.

A large amount of road construction work was carried on during the year, particularly in the Southern District in and around Balboa and Ancon. The extension of the Balboa town-site improvement was commenced in March and was in progress during the rest of the year. This consists of the necessary grading and the construction of streets and the installation of water and sewer lines in that part of Balboa lying between the present town and Ancon Hill, to take care of the new quarters to be built there during the ensuing year. All of the road construction during the year was of Telford base with concrete asphalt surface.

Several important items of construction work were performed by the municipal division for other divisions of The Panama Canal and the Panama Railroad and for the United States Army, a part of the work still being in progress at the close of the year. The principal items of work were the construction of the water and sewer systems and roads and pavements for the Army posts at Fort Amador and Fort Randolph, and the construction of pavements and the grading around the Balboa shops and terminals. Various uncompleted construction jobs pertaining to the Pacific terminals were turned over to the municipal division on May 1, 1916, when the Pacific terminal division was abolished, and this work was continued by the municipal division during the rest of the year. All of the work above outlined is described in detail in the municipal engineer's report which follows:

## MUNICIPAL DIVISION.

*D. E. Wright, Municipal Engineer.*

The organization of the division was intact throughout the year and was divided into the Southern District, under the supervision of Mr. W. J. Spalding, and the Northern District, under the supervision of Mr. E. H. Chandler (these districts performing the construction and maintenance work), and the division of purification plants under the supervision of Mr. George C. Bunker, physiologist. The work as outlined will be given by districts under the heads of "Construction" and "Maintenance."

## SOUTHERN DISTRICT.

In the Southern District the following work was authorized done for the United States Army at the various points designated and is detailed under the authorities for expenditures as issued:

*Extension of water lines from Naos Island to Perico and Flamenco Islands.*—This work consisted of 480 cubic yards of excavation and back fill, the laying of 2,537 linear feet of 6-inch cast-iron pipe, 1,356 linear feet of 4-inch cast-iron pipe, with the necessary fittings, connections, etc. Total cost of work, \$2,964.94.

*Grading around staff officers' quarters on Quarry Heights.*—This work consisted of 19,530 square yards of grading, 445 square yards of Telford laid, 445 yards of asphaltic concrete placed, and 196 cubic yards of excavation and fill. Total cost, \$3,228.62.

*Necessary grading for staff officers' quarters and the removal of track in the vicinity of the commanding general's quarters, Balboa Heights.*—This work consisted of 309 cubic yards of excavation, 7,588 square yards of grading, 288 square yards of Telford placed, 733 square yards of asphaltic concrete laid, 200 linear feet of 6-inch cast-iron pipe lowered, and 6 house connections made. Total cost, \$1,213.44.

*Installation of sewer for provost guard on Ancon Hill.*—This work consisted of 340 cubic yards of excavation, 166 cubic yards of back fill, 1,326 linear feet of 6-inch vitrified pipe, 36 linear feet of 10-inch vitrified pipe, and 12 manholes constructed. Total cost, \$1,127.72.

*Construction of sidewalks around staff quarters in accordance with approved plan submitted by headquarters office.*—This work consisted of 325 cubic yards of excavation, 400 square yards of gravel walks, 1,708 linear feet of concrete edging, and 10 clothes racks constructed and painted. Total cost, \$1,391.14.

*Construction of concrete drain along proposed new road on Quarry Heights, the construction of a basket gutter around the provost guard barracks as an eave drain, and doing the necessary grading in connection with same.*—This work consisted of 350 cubic yards of excavation, 946 linear feet of basket gutter constructed, 790 linear feet of concrete gutter for roof drip, at a total cost of \$1,382.47.

*Construction of 25-foot section of retaining wall on above road.*—This work consisted of 50 linear feet of concrete gutter, 1 catch basin, and 120 linear feet of 10-inch drain. Total cost to June 30, 1916, \$220.63.

## COROZAL DISTRICT.

*Construction of roads and installation of water and sewer mains for Ambulance and Signal Corps.*—This work consisted of 1,236 cubic yards of excavation, 236 cubic yards of back fill, 850 linear feet of curb and gutter, 793 linear feet of basket gutter, 4 catch basins with necessary covers, 86 linear feet of 8-inch vitrified pipe, 633 linear feet of 12-inch vitrified pipe, 7 manholes constructed and necessary covers placed, and 3,750 square yards of macadam road constructed. Total cost, \$9,907.34.

*Construction of roads and installation of water and sewer mains for Cavalry stables.*—This work consisted of 2,730 cubic yards of excavation, 337 cubic yards of back fill, 7 manholes constructed and necessary covers placed, 7 catch basins constructed, 2 fire hydrants installed, 1,713 square yards graded, 154 linear feet of 6-inch vitrified sewer pipe laid, 160 linear feet of 8-inch vitrified sewer pipe laid, 229 linear feet of 10-inch vitrified sewer pipe laid, 822 linear feet of 12-inch vitrified sewer pipe laid, 606 linear feet of 4-inch cast-iron pipe laid, 634 linear feet of 8-inch cast-iron pipe laid, 15,462 square yards of roadbed subgraded, 1,553 linear feet of curb and gutter constructed, 698 linear feet of basket gutter constructed, 128 square yards of concrete pavement placed, 74 linear feet of road culvert constructed, 724 linear feet of earth ditch graded, 15,462 square yards of macadam placed, rolled, and oiled. Total cost, \$12,785.28.

*Construction of roads and installation of water and sewer mains for Artillery stables.*—This work consisted of 552 cubic yards of excavation, 364 cubic yards of back fill, 3,909 cubic yards of excavation for road, 1,111 square yards of roadbed rolled, 228 linear feet of 6-inch sewer pipe laid, 675 linear feet of 8-inch sewer pipe laid, 472 linear feet of 10-inch sewer pipe laid, 823 linear feet of 12-inch sewer pipe laid, 2 fire hydrants

installed, two 21-inch fire plugs installed, 10,383 square yards of roadbed graded, 560 linear feet of 4-inch cast-iron pipe laid, 635 linear feet of 8-inch cast-iron pipe laid, 930 linear feet of curb and gutter constructed, 442 square yards of concrete pavement laid, 10,333 square yards of macadam road placed, rolled, and oiled. Total cost, \$13,060.12.

Under the combined authority for grading and filling for the Artillery and Cavalry stables the following work was done: Made 3,802 cubic yards of excavation and 283 cubic yards of fill and leveled and drained 8,200 square yards of area. Total cost, \$7,329.94.

*Construction of road from Artillery stables to incinerator.*—This work consisted of 210 cubic yards of excavation, 770 linear feet of earth ditch, 207 square yards of Telford placed, and 540 square yards of macadam placed, rolled, and oiled. This work is 40 per cent completed.

*Construction of road from Artillery stables to Ordnance storehouse, with water and sewer connections for storehouse.*—This work consisted of 468 cubic yards of excavation, 400 cubic yards of fill, 327 cubic yards of back fill, 500 linear feet of 6-inch vitrified pipe laid, 24 linear feet of 6-inch cast-iron pipe laid, 890 linear feet of 8-inch cast-iron pipe laid, 700 linear feet of 1-inch galvanized-iron pipe, 1 fire hydrant placed, 2 manholes constructed with necessary covers, 2 catch basins constructed, and 297 square yards of macadam road constructed and oiled.

#### BALBOA DISTRICT.

Work was completed during the fiscal year under the authority for the installation of water, sewers, streets, service roads, clearing, and grading at Coast Artillery Fort Grant District, chargeable to the \$700,000 appropriation, and during the fiscal year the following work was performed under this authority:

One thousand six hundred and seventy-five cubic yards of excavation, 218 cubic yards of back fill, 8,194 square yards of grading for parade grounds, 1,243 linear feet of curb and gutter, 177 linear feet of 10-inch vitrified sewer pipe laid, 790 square yards of macadam road constructed, 647 square yards of asphalt walk laid, 61 square yards of concrete walk laid, 133 square yards of gravel walk laid.

Work was also completed for the Coast Artillery Fort Grant District on the authority chargeable to the \$1,290,000 appropriation by Congress during the fiscal year, and the following work was done on this authority:

Four thousand three hundred and ninety-six cubic yards of excavation, 631 cubic yards of back fill, 8,710 cubic yards of fill, 1,307 linear feet of roadway graded, 9,412 square yards of No. 1 rock placed, 12,238 square yards of No. 2 rock placed, 15,012 square yards of screenings placed, 6,900 linear feet of curb and gutter constructed, 6 manholes built with necessary covers, 8 catch basins constructed, 256 linear feet of 8-inch vitrified pipe laid, 954 linear feet of 6-inch vitrified pipe laid, 946 linear feet of 8-inch cast-iron water pipe laid, 12 linear feet of 6-inch cast-iron pipe laid, 2 fire hydrants installed, 11,745 square yards of grading for lot improvements, 264 square yards of gravel sidewalk constructed, 551 square yards of concrete pavement laid, 42,583 square yards of road oiled, 1,641 square yards of grading in front of barracks for concrete walk made, 923 square yards of concrete pavement laid, 16 catch basins for down spouts constructed, and 450 linear feet of 3-inch pipe and down spouts laid.

*Grading for building sites.*—This work consisted of 5,050 square yards and 900 cubic yards of excavation and fill.

*Installation of water and sewer storehouse, Fort Amador.*—This work consisted of 170 cubic yards of excavation and back fill, 256 linear feet of 8-inch vitrified pipe laid, 218 linear feet of 6-inch cast-iron pipe laid, 2 manholes constructed with necessary covers, 2 fire hydrants installed. Total cost, \$298.46.

This completed the Army construction work in the Southern District for the year.

#### HEALTH DEPARTMENT.

Under authority for expenditure the following construction work was performed for the health department:

*Extension of road to medical storehouse, Ancon.*—This work consisted of 9 cubic yards of excavation, 50 linear feet of curb and gutter removed, 67 linear feet of curb and gutter replaced, 10 linear feet of 10-inch vitrified pipe laid, 1 catch basin installed, 58 square yards of Telford laid, and 58 square yards of asphaltic concrete placed. Total cost, \$189.69.

*Construction of road and sidewalks, new crematory, Ancon Hospital grounds.*—This work consisted of 30 cubic yards of excavation, 725 square yards of grading, 225 linear feet of curb and gutter constructed, 14 linear feet of retaining wall fill, 1 catch basin installed, 40 square yards of concrete pavement laid, 176 square yards of asphaltic concrete placed on macadam base. Total, \$708.31.



*Construction of road on southerly end of new hospital building group.*—This work consisted of 480 cubic yards of excavation and back fill, 500 square yards of grading, 1,154 linear feet of curb and gutter constructed, 7 catch basins, 38 linear feet of 10-inch vitrified pipe laid, 170 linear feet of concrete basket gutter constructed, 471 square yards of asphaltic concrete placed on macadam base, and 534 square yards of macadam road constructed. Total cost, \$3,496.16.

*Extension of Palo Seco sewer system to low tide.*—This work consisted of 20 cubic yards of excavation, 1,050 linear feet of 8-inch wrought-iron pipe placed on piers laid, total cost \$790, and the purchase and installation of a motor-driven deep-well pump for Palo Seco. Total cost, \$2,205.78.

*Construction of concrete sidewalks to Balboa quarantine station.*—This work consisted of 208 cubic yards of excavation, 1,059 square yards of subgrade rolled and tamped, and 1,059 square yards of concrete pavement placed. Total cost, \$1,571.49.

*Lowering of culvert under railroad track, Miraflores Locks, for drainage of Corozal Farm.*—This work consisted of 1,227 cubic yards of excavation, 1,227 cubic yards of back fill, 254 linear feet of 24-inch dredge pipe laid, 1,620 feet of three-quarter inch reinforcing steel used, and 95 cubic yards of concrete placed. Total cost, \$1,262.46.

*Clearing of growth in rear of Red Tank Encampment.*—This work consisted of 13,888 square yards cleared. Cost, \$93.26.

*Draining of pond in rear of Paraiso Corral.*—This work consisted of 345 cubic yards of excavation, 245 cubic yards of back fill, 150 square yards of grading, 290 linear feet of concrete ditch constructed, 420 linear feet of 24-inch dredge pipe for forms used, and 27 cubic yards of concrete placed. Total cost, \$1,768.84.

*Draining of pond in vicinity of railroad station, Paraiso.*—This work consisted of 810 cubic yards of excavation, 800 cubic yards of back fill, 390 linear feet of 30-inch cast-iron pipe laid, 7 cubic yards of concrete placed, 1 manhole constructed, and trestle driven for supporting the railroad tracks while drain was being laid. Total cost, \$2,705.67.

*Grading and straightening of ditches in Miraflores District.*—This work consisted of 1,290 cubic yards of excavation, 1,360 linear feet of ditches realigned and cleaned. Total cost, \$1,036.96.

*Filling of pond in Paraiso District.*—This work consisted of 150 cubic yards of excavation and 150 cubic yards of back fill. Total cost, \$169.81.

*Construction of road, sidewalk, and fence, Corozal Cemetery.*—This work consisted of 554 cubic yards of excavation, 2,818 square yards of grading, 642 square yards of macadam road built, 1 culvert constructed, 125 concrete posts made and placed, and 1,466 linear feet of fence built. Total cost, \$2,113.77.

*Oiling and sanding of roads in insane asylum grounds.*—This work consisted of 3,855 square yards of road oiled and sanded. Cost, \$126.87.

*Grading and filling in arm of Pedro Miguel Lake in vicinity of quartermasters' stables.*—This work consisted of 200 cubic yards of excavation, 200 cubic yards of back fill. Total cost, \$124.38.

*Cleaning and grading around edge of Pedro Miguel Lake.*—This work consisted in the removal of trees and other refuse. Cost, \$104.45.

*Construction of sanitary drains at Red Tank Encampment.*—This work consisted of 2,698 linear feet of concrete basket gutter constructed, 503 cubic yards of excavation, 2,200 square yards of grading, 20 linear feet of 24-inch pipe laid, and 714 linear feet of 8-inch and 10-inch tile drain laid. Total cost, \$2,352.53.

*Filling and grading of ditches, native town of Paraiso.*—This work consisted of 2,000 linear feet of ditches back filled, 500 linear feet of new ditches constructed. Total cost, \$331.04.

*Construction of drainage ditches, Santa Cruz district.*—This work consisted of 252 linear feet of concrete ditches constructed, 54 cubic yards of rubble masonry wall built, 9 cubic yards of concrete wall built, 90 cubic yards of excavation, 64 cubic yards of back fill, 45 cubic yards of stone placed in rubble ditch, 321 square yards of grading, and 1 culvert with necessary head wall constructed. Total cost, \$883.32.

*Concrete drains in vicinity of Ancon corral.*—This work consisted of 6 cubic yards of excavation, 119 square yards of grading, and 60 linear feet of 10-inch drain installed. Total cost, \$117.70.

*Construction of concrete drain south of Ancon corral.*—This work consisted of 50 cubic yards of excavation, 200 square yards of grading, and 378 linear feet of basket gutter constructed. Total cost, \$201.23.

*Repairs to drain in vicinity of Ancon fire station.*—This work consisted of 80 linear feet of grout drain placed. Cost, \$13.39.

*Construction of concrete drain around houses located on flat at Pedro Miguel.*—This work consisted of 1,870 linear feet of concrete gutter constructed, 302 cubic yards of excavation, and 1,680 square yards of fill placed under houses. Total cost, \$1,860.



The maintenance work done for the sanitary department on their request is included under "General Maintenance Work for the Canal Zone," the above being only the more important items of construction requested by them in the Southern District during the year.

## MARINE DIVISION.

*Construction of macadam road at pilot's quarters in the vicinity of quarantine station, Balboa.*—This work consisted of 800 cubic yards of excavation, 845 cubic yards of fill, 1,617 square yards of grading, 190 linear feet of fence constructed, 1,300 square yards of road macadamized, oiled, and sanded, and 100 linear feet of curb and gutter placed. Total cost, \$2,346.85.

*Installation of fire protection for pilots at Balboa.*—This work consisted of 75 cubic yards of excavation, 75 cubic yards of back fill, 300 linear feet of 6-inch cast-iron pipe laid, and 1 fire hydrant installed. Total cost, \$302.02.

## MECHANICAL DIVISION AND TERMINAL CONSTRUCTION.

These two divisions were combined with a view to a large proportion of the outside work for terminal construction division being turned over to the mechanical division for the purpose of issuing work requests on other divisions.

*Construction of drain from oil tank farm to the ocean.*—This work consisted of 380 cubic yards of excavation, 330 cubic yards of back fill, 164 linear feet of 12-inch vitrified pipe laid, and 6 cubic yards of concrete for head walls. Total cost, \$971.41.

*Installation of fire wall around United States oil tank No. 5.*—This work consisted of 400 cubic yards of excavation, 4,111 cubic yards of fill, 50 linear feet of rubble masonry, consisting of 28 cubic yards of material erected, and 30 cubic yards of sand cushion placed and oiled. Total cost, \$2,453.96.

*Construction of gravel walks across tank farm, with necessary grading.*—This work consisted of 8,800 square yards of gravel walk placed. Total cost, \$985.84.

*Locating of path and the installation of drain to lots Nos. 13 and 14, tank farm.*—This work consisted of 35 cubic yards of excavation, 25 linear feet of 15-inch vitrified pipe placed, and 57 square yards of gravel path built. Total cost, \$98.03.

*Drainage ditches from private company's oil lots, Balboa.*—This work consisted of 243 cubic yards of excavation, 243 cubic yards of back fill, 283 linear feet of 10-inch vitrified pipe laid, 494 linear feet of 15-inch vitrified pipe laid, and 5 manholes constructed. Total cost, \$813.05.

*Manufacture of necessary concrete posts, and the erection of wire fence around the tank farm, Balboa.*—This work consisted of 247 concrete posts made and placed, 80 cubic yards of excavation made, 5,000 linear feet of fence erected. Total cost, \$611.68.

*Erection of fire wall around tank No. 36, Balboa.*—This work consisted of 928 cubic yards of excavation, 1,255 cubic yards of fill made, 1 catch basin installed, 40 linear feet of 8-inch galvanized-iron pipe laid. Total cost, \$484.25.

*Construction of fire wall around gasoline tank No. 31, Balboa.*—This work consisted of 400 cubic yards of excavation, 700 cubic yards of fill, and 60 linear feet of 6-inch vitrified pipe. Total cost, \$396.41.

*Erection of barbed wire fence around gasoline tank No. 31 and grading of ground.*—This work consisted of 360 square yards graded, and 628 linear feet of fence erected, and the necessary concrete posts manufactured for same. Total cost, \$292.54.

*Cutting of grass and undergrowth on tank farm, Balboa.*—This work consisted of clearing and burning over 28 acres. Cost, \$616.97.

*Installation of water pipes in shops' tunnel.*—This work consisted of 1,500 linear feet of 4-inch galvanized-iron pipe, with the necessary fittings, laid. Total cost, \$487.51.

*Installation of pipe and necessary fittings in the vicinity of the oil-handling plant, Balboa.*—This work consisted of 2,100 linear feet of 6-inch galvanized iron pipe laid, with the necessary fittings. Cost, \$504.58.

*Installation of 10-inch oil line to oil crib No. 1.*—This work consisted of 1,225 linear feet of 10-inch extra heavy pipe laid, with necessary fittings. Cost, \$3,438.23.

*Construction of gasoline oil line from storage tank No. 31 to oil crib.*—This work consisted of 1,200 linear feet of 4-inch extra-heavy pipe, with necessary fittings. Cost, \$1,009.33.

*Lowering and back filling of the Balboa-Paraiso oil line.*—This work consisted of 3,000 linear feet of pipe lowered and back filled. Cost, \$1,993.52.

*Extension of oil line to Old Panama-Railroad Dock, Balboa.*—This work consisted of 1,180 linear feet of 10-inch extra-heavy galvanized pipe laid across the arm of the bay to the dock, 1,000 feet of 8-inch extra-heavy pipe laid as a header under the steel decking of the dock, with 8 connections for oiling ships made, each of these connections necessitating reducers for 6-inch oil hose, and the installation of 8-inch extra-heavy valves with special opening device. Total cost, \$4,023.04.

*Grading around and placing of paths at the oil-handling plant, Balboa.*—This work consisted of 4,594 square yards of grading done, and ground covered with gravel and screenings. Total cost, \$870.28.

*Installation of air line for unloader and reloader wharves, Balboa.*—This work consisted of the laying of 1,725 linear feet of 4-inch galvanized iron pipe, with necessary outlets for hose connections. Cost, \$780.01.

*Installation of pipe in openings of Dry Dock No. 1, Balboa.*—This work consisted of miscellaneous sizes of pipe, and was all special work, the pipe being incased in the concrete of the dry dock walls. Total cost, \$2,720.83.

*Installation of water pipe from building No. 29 along the south side of Dry Dock No. 1, and around the head and along the north side as far as station 13 plus 99, including outlets in the dry docks.*—This work consisted of 230 cubic yards of excavation, 230 cubic yards of back fill, 410 linear feet of 10-inch cast-iron pipe laid, 1,704 linear feet of special flange pipe laid, 1,109 linear feet of 6-inch cast-iron pipe laid, 102 linear feet of 4-inch cast-iron pipe laid, 1,476 linear feet of 4-inch galvanized iron pipe laid, 192 linear feet of 8-inch extra-heavy pipe laid, 24 linear feet of 2-inch pipe laid for fire plugs. Total cost, \$1,453.85. The material for this work was furnished by the terminal division, and not included in the cost of the work as shown.

*Installation of 8-inch water main, with 2½-inch branch lines, for Docks Nos. 13, 14, 15, and 16.*—This work consisted of 18 cubic yards of excavation, 18 cubic yards of back fill, 544 linear feet of 3-inch galvanized-iron pipe laid, 360 linear feet of 4-inch galvanized-iron pipe laid, 2,484 linear feet of 8-inch galvanized-iron pipe laid, 30 pipe hangers made and installed, five 3-inch water meters placed with necessary covers, and six 3-way fire hydrants installed. Total cost, \$7,072.39.

*Construction of water lines for coal-handling plant.*—This work consisted of 300 cubic yards of excavation, 300 cubic yards of back fill, 3,485 linear feet of 6-inch cast-iron pipe laid, 1,100 linear feet of 4-inch galvanized-iron pipe laid, 1,000 linear feet of 3-inch galvanized-iron pipe laid, 475 linear feet of 2½-inch and 2-inch galvanized-iron iron pipe laid, thirteen 2-inch fire plugs installed, two 4-inch meters placed, and four 3-inch meters placed. Total cost, \$2,740.

*Grading around Balboa shops buildings.*—Ten square yards graded. This work is 75 per cent completed.

*Asphaltic concrete placed on approach to Pier No. 18.*—This work consisted of 184 square yards of asphaltic concrete laid. Cost, \$170.64.

*Water line in vicinity of dredge ditch at fuel-oil handling plant reclaimed and relaid.*—This work consisted of 375 cubic yards of excavation, 375 cubic yards of back fill, and 1,500 linear feet of 6-inch cast-iron pipe taken up and relaid. Total cost, \$541.55.

#### MISCELLANEOUS.

The following is a list of miscellaneous work requests placed on the municipal division by the various divisions of The Panama Canal in the Southern District:

*Installation of 10,000-gallon gasoline tank for motor-car house, Balboa.*—This work consisted of 96 cubic yards of excavation, 15 cubic yards of concrete placed, 120 linear feet of three-fourths-inch galvanized-iron pipe laid, 140 linear feet of 1-inch galvanized-iron pipe laid, 160 linear feet of 2-inch galvanized-iron pipe laid, and the installation of 2 Bowser pumps for the handling of the gasoline. Total cost, \$571.14.

*Construction of road from material yard to substore No. 6, Balboa.*—This work consisted of 549 cubic yards of excavation, 1,609 square yards of Telford placed, 1,467 square yards of asphaltic concrete laid, 142 square yards of concrete pavement placed, and 30 feet of 10-inch cast-iron pipe for drain. Total cost, \$3,504.58.

*Installation of fire protection for material yard at substore No. 6, Balboa.* This work consisted of 118 cubic yards of excavation, 118 cubic yards of back fill, 132 feet of 6-inch cast-iron pipe laid, 660 feet of 6-inch galvanized-iron pipe laid, and 3 fire hydrants installed. Total cost, \$486.76.

*Excavation for swimming pool, Balboa.*—This work consisted of 3,740 cubic yards of excavation costing \$1,414.67, sewer connection for swimming pool, 38 cubic yards of excavation, 38 cubic yards of back fill, 120 feet of 10-inch cast-iron pipe, 92 feet of 6-inch vitrified pipe, costing \$261.87.

*Construction of macadam road from quarantine station to yacht club.*—This work consisted of 200 cubic yards of excavation, 800 square yards of macadam road constructed, oiled, and sanded. Total cost, \$539.82.

*Construction of walk and handrail on retaining walls, Miraflores Locks spillway.*—This work consisted of 180 cubic yards of excavation, 533 square yards of gravel path laid, and 300 linear feet of handrail built. Total, cost \$208.80.

*Installation for Panama Railroad of 8-inch cast-iron water line from salt-water pumping station to the ice plant, Balboa.*—This work consisted of 289 cubic yards of excavation, 289 cubic yards of back fill, 1,527 linear feet of 8-inch cast-iron pipe with necessary fittings. Total cost, \$2,274.68.

*Installation of 6-inch water line from salt-water pumping station to swimming pool, Balboa.*—This work consisted of 310 cubic yards of excavation, 310 cubic yards of back fill, and 2,135 linear feet of 6-inch cast-iron pipe with necessary fittings laid. Total cost, \$2,033.85.

*Construction of a concrete flume from the Rio Grande diversion to the canal.*—This work consisted of 3,703 cubic yards of excavation, 2,500 cubic yards of back fill against side walls, and 545 cubic yards of concrete placed. There were used 100 tons of old steel rails, and 20,376 pounds of reinforcing steel. Total cost, \$11,222.59.

*Grading and constructing concrete drains at Darien Radio Station.*—This work consisted of 1,571 linear feet of concrete ditch constructed, and the necessary grading done. Total cost, \$774.99.

*Reclamation of 10-inch extra-heavy wrought-iron pipe for building division.*—This work consisted of 7,335 linear feet of 10-inch extra-heavy wrought-iron pipe reclaimed, and 1,300 linear feet of 3½-inch by 4-inch galvanized pipe relaid. Total cost, \$2,750.85.

*Construction of tennis court for private party.*—The necessary grading was done, and 700 square yards of concrete, 1½-inch thick, was placed, at a cost of \$208.31.

#### STRAIGHT MUNICIPAL CONSTRUCTION WORK.

Under the head of "Straight Municipal Construction Work" the following was performed in the Southern District:—

*Staking out and completing of municipal work for the Red Tank Camp.*—This work consisted of 286 cubic yards of excavation, 383 cubic yards of back fill, 884 linear feet of 6-inch vitrified pipe laid, 1,600 linear feet of 8-inch vitrified pipe laid, 100 linear feet of 1½-inch galvanized pipe laid, and 300 linear feet of 2-inch galvanized pipe laid. Total cost, \$3,387.41.

*Installation of road to Balboa shops office building.*—This work consisted of 1,497 cubic yards of excavation, 5,195 linear feet of curb and gutter, 6,070 square yards of Telford base laid, 6,070 square yards of asphaltic concrete placed, 130 linear feet of 6-inch vitrified pipe laid, and 490 linear feet of 8-inch vitrified pipe laid. Total cost, \$16,477.94.

*Construction of road through Balboa shops to and around the dry dock.*—This work consisted of 300 cubic yards of excavation, 600 cubic yards of fill, 13,000 square yards of macadam base placed, 13,000 square yards of asphaltic concrete placed, 8 catch basins installed, and 2,100 linear feet of curb and gutter placed. Total cost, \$19,089.58 to date. This work is 75 per cent complete.

*Completion of terminal road in Ancon District through "Bishop's Hollow."*—This work consisted of 300 cubic yards of excavation, 180 cubic yards of back fill, 1,160 linear feet of curb and gutter placed, 12 catch basins installed, 2,637 square yards of Telford base laid, 3,850 square yards of asphaltic concrete placed, 30 cubic yards of concrete pavement laid, 198 linear feet of 6-inch vitrified pipe laid, 100 linear feet of 10-inch vitrified pipe laid, 25 linear feet of 6-inch cast-iron pipe laid. Total cost, \$9,155.19.

*Construction of road to silver market, Ancon.*—This work consisted of 92 cubic yards of fill, 336 square yards of macadam road constructed, 200 linear feet of basket gutter constructed. Total cost, \$687.35.

*Construction of road in vicinity of old Administration Building, Ancon.*—This work consisted of 45 cubic yards of excavation, 21 linear feet of basket gutter constructed, 89 linear feet of 6-inch vitrified pipe laid, 22 linear feet of 8-inch galvanized pipe laid, 28 linear feet of 10-inch cast-iron pipe laid, and 253 square yards of macadam road constructed. Total cost, \$307.05.

*Reconstructing road to Tivoli Hotel kitchen.*—This work consisted of 830 square yards of macadam placed, rolled, oiled, and sanded. Cost, \$347.11.

*Construction of approach to garage in vicinity of quartermaster's storehouse, Balboa.*—This work consisted of 187 cubic yards of fill, 240 square yards of Telford placed, 240 square yards asphaltic concrete pavement laid, 55 linear feet curb and gutter placed. Total cost, \$468.62.

*Construction of road to garage in vicinity of Cemetery Ridge.*—This work consisted of 185 cubic yards of fill, 274 square yards of macadam base placed, 278 square yards of asphaltic concrete laid. Total cost, \$477.51.

*Construction of road in rear of new ice plant, Balboa.*—This work consisted of 105 cubic yards of excavation, 436 square yards graded, 486 square yards of Telford base laid, 564 square yards of asphaltic concrete placed, and 281 linear feet of curb and gutter constructed. Total cost, \$1,037.48.

*Construction of asphaltic concrete road in vicinity of Tivoli Hotel.*—This work consisted of 430 cubic yards of excavation, 3,782 linear feet of curb and gutter constructed, 3,600 square yards of Telford base laid, 3,600 square yards of asphaltic concrete placed, 280 square yards of grading on side of road, 955 linear feet of retaining wall built, 13 catch basins installed, and 17 concrete platforms laid to house steps. Total cost, \$1,322.43.

*Extension of sewer outfall, Corozal.*—This work consisted of 241 cubic yards of excavation, 224 cubic yards of back fill, 600 linear feet of 12-inch vitrified pipe laid, and 4 manholes constructed, with necessary covers. Total cost, \$2,047.23.

*Installation of sewer lines at silver quarters, Paraiso.*—This work consisted of 67 cubic yards of excavation, 67 cubic yards of back fill, and 300 linear feet of 6-inch vitrified pipe laid. Total cost, \$188.25.

*Installation of rock crusher, with necessary equipment, at Gamboa.*—This work consisted of 259 cubic yards of excavation, 52 cubic yards of concrete placed, and material for bins and the necessary equipment for the plant installed. Total cost, \$12,407.98.

*Construction of Empire-Gamboa road.*—This work consisted of 14,629 cubic yards of excavation, 4,811 square yards of Telford base placed, 11,643 square yards of Telford base covered with 4 inches of No. 2 rock and screenings, 2,000 lineal feet of ditches constructed, 300 linear feet of 18-inch concrete pipe laid, 131 linear feet of 24-inch pipe laid, 6 acres of right of way cleared, 90 cubic yards of concrete placed in head walls of culverts, and one bridge of two 25-foot spans constructed. This work is 75 per cent completed.

On the first of May, due to the abolishing of the terminal construction division, a blanket authority was issued on the municipal division to complete certain portions of work then under way. The cost of the work on this request completed prior to June 30 amounted to approximately \$60,000, it consisting of the manufacture and the placing of vertical and horizontal fender piles along the dock, riprapping surfaces in the rear of the reloader wharf, and Piers Nos. 17 and 19, the placing of tie rods on the caissons in Pier No. 18 and the reloader wharf, the laying of approximately 2,000 square yards of brick pavement on Pier No. 18, the placing of foundations for the berm crane runway, the erecting of retaining walls for one of the coal bunkers and the grouting of same, the surfacing with asphalt of the 4 pontoon barges used as landing platforms for the small craft in the harbor, and a number of minor jobs that were practically complete when the division was abolished.

During the year construction work was continued on the old townsite of Balboa, and the following work was done:

Excavation.....	cubic yards..	80,498
Telford base.....	square yards..	18,548
Asphalt concrete (streets).....	do.....	18,321
Gutter.....	linear feet..	7,754
Miscellaneous concrete (steps, etc.).....	cubic yards..	694
Sewer pipe laid:		
6-inch.....	linear feet..	1,771
8-inch.....	do.....	1,408
10-inch.....	do.....	420
12-inch.....	do.....	805
15-inch.....	do.....	63
Total.....	do.....	4,567
Ditches.....	do.....	3,266
Gravel walk.....	do.....	2,649
Asphalt concrete walks.....	do.....	9,643
Manholes built.....	only.....	30
Water pipe laid:		
4-inch.....	linear feet..	35
6-inch.....	do.....	60
		95
Grading.....	square yards..	75,912
Grounds planted (sodded).....	do.....	207,423

The making of the necessary service for, and the construction of, the proposed new townsite extension, Balboa, was started during the year, and the following work had been done to June 30, 1916:

*Streets.*

Graded.....	square yards..	24,763
Excavation.....	do.....	12,226
Curb and gutter.....	linear feet..	19,445
Fill and back fill.....	cubic yards..	1,254
Forms for curb and gutter.....	linear feet..	13,230
Asphaltic concrete placed.....	square yards..	13,903
Catch basins built.....	only.....	24
Retaining wall.....	linear feet..	433
Total cost, \$29,916.89.		

*Sanitary and storm sewers.*

Excavation.....	cubic yards..	10,664
Back fill.....	do.....	8,700
Concrete ditches.....	linear feet, 1 by 2 feet..	896
Manholes built.....	only..	8
Concrete culvert.....	linear feet..	90
Storm sewer:		
4 by 4 feet.....	do.....	22
3 by 3 feet.....	do.....	539
Sewer pipe laid:		
6-inch.....	do.....	2,666
8-inch.....	do.....	4,834
10-inch.....	do.....	1,046
12-inch.....	do.....	2,040
15-inch.....	do.....	535
18-inch.....	do.....	66
Concrete pipe, 20-inch.....	do.....	246
Total cost, \$13,723.43.		

*Water line.*

Excavation.....	cubic yards..	2,555
Back fill.....	do.....	351
Hydrants installed.....	only..	3
Valve boxes built, 3 by 5 feet.....	do.....	7
Water pipe laid, cast iron:		
4-inch.....	linear feet..	1,874
6-inch.....	do.....	3,878
8-inch.....	do.....	3,470
10-inch.....	do.....	540
12-inch.....	do.....	36
Total cost to date, \$10,203.91.		

*Grading and planting.*

Excavation.....	cubic yards..	4,056
Graded.....	square yards..	17,525
Filled.....	cubic yards..	16,028
Total cost to date, \$18,853.01.		

The total work in connection with the construction of the new townsite of Balboa, was 60 per cent completed on June 30, 1916.

## MAINTENANCE.

Under the head of "Maintenance" the following municipal work was done in the Southern District:

*Las Cascadas.*

Road repaired.....	square yards..	45,291
Road ditches cleaned.....	linear feet..	17,514
Water lines cleared.....	do.....	6,480
Sidewalks built.....	square yards..	304
Sidewalks repaired.....	do.....	380
Cast-iron pipe, 6-inch, removed.....	linear feet..	3,440
Tile, 6-inch, laid.....	do.....	480
Vitrified sewer, 6-inch, laid.....	do.....	50
Wrought iron pipe, 4-inch, laid.....	do.....	480

*Empire-Culebra.*

Road repaired.....	square yards..	9,958
Road ditches cleaned.....	linear feet..	90,320
Sanitary ditches cleaned.....	do.....	62,930
Water lines cleared.....	do.....	131,220
Clearing at Rio Grande Reservoir.....	square yards..	708,190
Clearing at Camacho Reservoir.....	do.....	194,725

*Paraiso-Pedro Miguel.*

Road repaired.....	square yards..	92,608
Road ditches cleaned.....	linear feet..	77,800
Sanitary ditches cleaned.....	do.....	15,168
New dirt ditches built.....	do.....	3,504
Concrete ditches constructed.....	do.....	6,844
Sanitary ditches filled with dirt.....	do.....	7,000
Road oiled.....	square yards..	46,304

*Corozal.*

Road repaired.....	square yards..	29,785
Road oiled.....	do.....	14,080
Road ditches cleaned.....	linear feet..	34,722
Sanitary ditches cleaned.....	do.....	206,703
Concrete ditches built.....	do.....	761
Basket gutter.....	do.....	3,182
Sidewalk repaired.....	square yards..	645

*Ancon-Balboa.*

Subdrain tile laid.....	linear feet..	6,650
Concrete drain built.....	do.....	19,467
Ditches cleaned.....	do.....	125,642
Road repaired.....	square yards..	147,664
Road oiled.....	do.....	49,347
Grading done.....	do.....	30,436

*Water sold to ships in Southern District.*

Month.	Number of steamers.	Gallons of water.
1915.		
July.....	44	1,086,900
August.....	40	799,120
September.....	56	1,553,800
October.....	172	4,783,900
November.....	80	1,934,400
December.....	53	1,518,500
1916.		
January.....	64	1,628,300
February.....	78	1,894,700
March.....	72	1,812,100
April.....	64	1,546,200
May.....	42	1,144,300
June.....	45	1,200,000
Total.....	710	20,902,220

*Operation of pumping stations in Southern District.*

Station.	Average number of gallons pumped per month.	During the period.
Gamboa, U. S. No. 1.....	267,680,000	July 1, 1915, to June 30, 1916.
Miraflores, U. S. No. 2.....	29,956,666	Do.
Ancon, U. S. No. 3.....	194,561,236	Do.
Paraiso.....	6,219,146	Do.
Cucaracha (tanks).....	6,480,684	Do.
Cucaracha (Mount Zion).....	6,920,833	Do.
Camacho.....	4,515,181	Do.

## PANAMA CITY.

The following constitutes a summary of the more important construction work done in Panama City in addition to the regular maintenance work:

The construction of 1,000 linear feet of macadam road from East Twenty-fifth Street to dump No. 2, consisting of 1,650 square yards of macadam placed. Cost, \$490.80.

The construction of concrete ditches, the concreting of alleyways, the installation of water and sewer pipes, and the construction of macadam road in Santa Cruz district, consisting of 425 cubic yards of excavation, 280 cubic yards of back fill, 1,347 linear feet of curb and gutter, 432 linear feet of 6-inch cast-iron pipe, 2 catch basins installed, 1,840 square yards of grading, 1,200 square yards of macadam road constructed, and 2 fire hydrants installed. Total cost, \$2,718.96.

The covering of Calidonia Bridge with sheet asphalt, consisting of 915 square yards of sheet asphalt laid. Cost, \$549.

The sanitating of private stables on Fourth of July Avenue, to comply with regulations of the health department, consisting of 20 linear feet of 15-inch vitrified pipe laid, 135 linear feet of concrete gutter constructed, 138 square yards of concrete walk laid, 431 square yards of concrete floor placed in stables, 25 tin-lined feed boxes

built and installed, and 137 old feed boxes lined with sheet galvanized iron. Total cost, \$686.09.

Upon request of and deposit by private parties the street between I and J Streets was constructed, consisting of 800 cubic yards of excavation, 334 linear feet of 6-inch sewer pipe laid, 275 cubic yards of back fill, 1,098 linear feet of curb and gutter constructed, 713 linear feet of 8-inch sewer pipe laid, 5 manholes constructed, 30 house connections to sewer line made, 145 linear feet of 15-inch vitrified sewer pipe laid, 3 catch basins installed, 575 linear feet of 6-inch cast-iron pipe laid, 30  $\frac{1}{2}$ -inch lead connections for houses made, 1,100 square yards of macadam subbase placed and rolled, and 1,142 square yards of asphaltic concrete laid. Total cost, \$2,986.57.

The installation of a combined storm and sanitary sewer from the Panama Railroad stables to the sea, and the laying of a 6-inch cast-iron water line for the protection of the Panama Government's warehouses, consisting of 1,419 cubic yards of excavation, 1,081 cubic yards of back fill, 303 linear feet of 6-inch vitrified pipe for house connections, 153 linear feet of 8-inch vitrified pipe, 531 linear feet of 15-inch vitrified pipe, 1,268 linear feet of 20-inch concrete pipe, 7 manholes constructed, 1,222 linear feet of 6-inch cast-iron pipe laid, 20 linear feet of 4-inch cast-iron pipe laid, 800 linear feet of three-fourths-inch old pipe for house connections placed. Total cost, \$3,562.95.

The construction of curb and gutter in the vicinity of the Panama Railroad stables, consisting of 13 cubic yards of excavation, 402 linear feet of curb and gutter. Total cost, \$185.41.

Municipal work in connection with the extension of the Panama Railroad stables on the Sandoval tract, consisting of 147 cubic yards of excavation, 130 cubic yards of back fill, 115 linear feet of 10-inch vitrified pipe, 245 linear feet of 12-inch vitrified pipe, 66 linear feet of 15-inch vitrified pipe, 69 linear feet of 18-inch vitrified pipe, 4 manholes constructed, and two 2-inch fire plugs installed. Total cost, \$559.95.

Storm drains laid to sewer line from the caretaker's house, and the asphaltting of stalls in the Panama Railroad stables, consisting of 160 linear feet of 12-inch vitrified pipe laid, 19 manholes constructed, 910 linear feet of 8-inch vitrified pipe laid, and 584 stalls asphalted, a total of 1,491 square yards. Total cost, \$980.

Installation of fire protection for the Panama Railroad yard in the vicinity of the freight station, consisting of 312 cubic yards of excavation, 312 cubic yards of back fill, 60 linear feet of 6-inch cast-iron pipe installed, 408 linear feet of 4-inch cast-iron pipe installed, and one 3-way hydrant installed. Total cost, \$519.74.

The construction of concrete sidewalks at the Panama Railroad freight house along East Fifteenth Street and Northern Avenue to the end of the Panama Railroad property consisting of 94 cubic yards of excavation, 500 square yards of grading, 171 linear feet of straight curb, 424 linear feet of curb and gutter, 468 square yards of concrete sidewalk, 2 manholes raised, 130 linear feet of 12-inch vitrified pipe laid, 30 linear feet of 8-inch vitrified pipe laid, and 270 linear feet of fence reconstructed. Total cost, \$1,671.47.

The asphaltting of Avenue B in the vicinity of the Panama Railroad freight station to Twenty-third Street, paid jointly by the Panama Railroad and the Panama Government, consisting of 5,110 square yards of macadam base prepared, and 5,110 square yards of asphaltic concrete laid. Total cost, \$3,356.93.

The preparing of subgrade and the asphaltting of Northern Avenue in the vicinity of the Panama Tramway Co.'s car barn, consisting of 1,470 square yards of macadam subgrade prepared, and 1,470 square yards of asphaltic concrete laid. Total cost, \$955.50.

Under deposits by private parties all sewer and water connections in the City of Panama to private residences, factories, stables, etc., were made, and under deposits made at various times by the Panama Electric Tramway Co., repair work for them was done to the extent of \$3,021.38. All plumbing inspection work in the City of Panama, as well as inspection of plumbing in the Canal Zone, was handled by employees of the municipal division, as well as the collection of water rents in the City of Panama, a report of which is as follows:

*Consumption per quarter.*

Quarter ended.	Paying connections.	Private.	Public hydrants and taps.	Total.	Daily average consumption.
Sept. 30, 1915.....	2,305	150,395,000	91,410,000	241,805,000	2,686,722
Dec. 31, 1915.....	2,325	153,821,000	88,017,000	241,841,000	2,687,122
Mar. 31, 1916.....	2,350	162,288,000	106,180,000	268,468,000	2,982,977
June 30, 1916.....	2,390	159,377,000	102,653,000	262,030,000	2,911,444
Total for year.....		625,884,000	388,260,000	1,014,144,000	2,817,066

*Consumption per quarter—Continued.*

Quarter ended.	Amount collected from private consumers.	Average consumption per private connection per quarter.	Average private quarterly bill.
Sept. 30, 1915.....	\$37,766.95	65,247	\$16.38
Dec. 31, 1915.....	<sup>1</sup> 39,246.20	66,160	16.88
Mar. 31, 1916.....	<sup>2</sup> 41,533.75	66,058	17.67
June 30, 1916.....	<sup>3</sup> 40,616.25	66,685	16.99
Total for year.....	159,163.15	267,150	67.92

<sup>1</sup> Includes \$2,825 charge for water used in schools and other public buildings during the quarter. **Ap**proved for payment by the Government of Panama, but unpaid on account of lack of funds.

<sup>2</sup> Includes \$2,606.25 charge for water used in schools and other public buildings during the quarter. **Ap**proved for payment by the Government of Panama, but unpaid on account of lack of funds.

<sup>3</sup> Net amount of bills.

In addition to maintaining all the streets, water lines, and sewer lines in the City of Panama, the following construction work was done and charged to maintenance:

Water pipe, 6-inch cast iron.....	linear feet..	175
Water pipe, 4-inch cast iron.....	do....	130
Manholes built.....	.....	1
Asphalt, Tivoli Road.....	square yards..	2,975
Asphalt, Third of November Street.....	do....	1,171
Asphalt, I Street.....	do....	958
Asphalt, West Twentieth Street.....	do....	886
Asphalt, Balboa Street.....	do....	869
Asphalt, East Nineteenth Street.....	do....	124
Asphalt, Ancon Avenue and J Street.....	do....	80
Asphalt, B Street.....	do....	80

## NORTHERN DISTRICT.

In the Northern District the following are the more important items of construction performed by the municipal forces for other divisions of the canal and departments of the Government:

## UNITED STATES ARMY.

*Construction of water and sewer lines, roads and sidewalks and grading of grounds at Margarita Island (Fort Randolph).*—This work consisted of 640 linear feet of 12-inch pipe, 2,650 linear feet of 10-inch vitrified pipe, 260 feet of 8-inch vitrified pipe, 440 feet of 6-inch vitrified pipe, laid for road drains and culverts, and 6,970 linear feet of 8-inch cast-iron pipe, 1,050 feet of 6-inch cast-iron pipe, 1,375 linear feet of 4-inch cast-iron pipe, 1,080 linear feet of 2½-inch galvanized pipe, laid in the water system. Two thousand five hundred and seventy (2,570) linear feet of 6-inch cast-iron pipe were laid as a discharge from the sewerage sump to the sea, and 2,830 linear feet of 6-inch, and 2,590 linear feet of 8-inch vitrified pipe were laid for the sewerage system. The excavation for road grades, water lines, and sewer lines amounted to 3,916 cubic yards. Back fill amounted to 2,095 cubic yards. There were 16,700 linear feet of curb and gutter constructed and 4,927 square yards of concrete sidewalks laid. During road construction there were 48 catch basins installed and 14 standard fire hydrants placed.

*Municipal work at Margarita Island, Fort Randolph.*—This work consisted of the installation of water and sewers, the construction of sewerage and fresh-water pump stations, the installation of pumping equipment, the grading and preparing of sub-grades for streets, the construction of curb and gutter, the placing of macadam, the rolling and oiling of surfaces, the grading for and placing of concrete sidewalks, and grading an area in the vicinity of the quarters. In connection with the above the following work was done: Construction of drains from catch basins on streets, and the laying of 640 linear feet of 12-inch, 2,650 linear feet of 10-inch, 260 linear feet of 8-inch, and 440 linear feet of 6-inch vitrified pipe. The excavation and back fill for these drain lines amounted to 1,008 cubic yards. The installation of the sewer system consisted of 2,590 linear feet of 8-inch and 2,570 linear feet of 6-inch vitrified sewer pipe laid to the sewerage pump station. There were 2,004 cubic yards of excavation and back fill on these lines, and 18 manholes were constructed. From the sewerage pump station to the sea a 6-inch cast iron discharge line was laid—a distance of 2,560 feet. There were 904 cubic yards of excavation and back fill.



The water line installed consisted of the laying of 6,970 linear feet of 8-inch, 1,050 linear feet of 6-inch, and 1,375 linear feet of 4-inch cast-iron pipe, with necessary valves and house connections. There were 14 standard fire hydrants installed. The excavation and back fill on these lines amounted to 1,830 cubic yards. In connection with the installation of the water lines a by-pass was made to the pump station from the gravity feed line, and a fire pump installed for fire protection.

The excavation for subgrade and curb and gutters on streets amounted to 1,606 cubic yards, 16,700 linear feet of curb and gutter being constructed, and 13,880 square yards of macadam placed, rolled, oiled, and sanded.

Sidewalk construction consisted of the necessary grading and the placing of 4,927 square yards of concrete.

The grading around quarters consisted of a cut and fill over an area of 89,000 square yards.

The total cost of the municipal work at this point, including labor, all materials for construction purposes, and equipment for the pump stations, amounted to \$84,932.05.

*Municipal work performed upon special request at Toro Point (Fort Sherman).—*

This work consisted of the following: The staking out of permanent buildings erected, the construction of 3,235 linear feet of curb and gutter, and 4,067 square yards of macadam roadway, the laying of 250 linear feet of 8-inch vitrified pipe for road drains, the construction of 100 linear feet of concrete block culverts, 177 linear feet of basket gutter, and 725 linear feet of concrete ditch, with a section 4 inches wide at the top, 1½ feet wide at the bottom, and 1½ feet deep, with 6-inch side walls. Of the 3,259 linear feet of roadway built, it was necessary to corduroy 1,947 linear feet. The total cost of the work at this point was \$12,413.10.

Upon special authority a new pump, with necessary electrical equipment for operating same, was installed at Fort Sherman. The cost of this work, including equipment, was \$1,435.40.

*Installation of relay pump station.*—Upon special authority a relay pump station, for temporary purposes, was installed at Mount Hope, furnishing water to Fort Randolph. The cost of necessary connections, and the installation of this pump and equipment, amounted to \$1,216.16.

*Surveys and estimates for new Army Post.*—Upon special request surveys and estimates were made covering the new Army Post to be constructed at Fort Sherman. The cost of making the surveys, including the getting out of the necessary estimates, blue prints, etc., was \$1,265.68.

#### TERMINAL CONSTRUCTION.

*Installation of oil lines to Cristobal coaling plant.*—Upon special request from the terminal construction division, two 10-inch oil lines were installed from Dock No. 13 across the channel in a depth of 45 feet of water to the Cristobal coaling plant. This work consisted of the laying of 1,291 linear feet of 10-inch, double, extra heavy, galvanized pipe, 865 linear feet of 6-inch extra heavy galvanized pipe, 4,946 linear feet of 8-inch extra heavy galvanized pipe. Excavation and back fill in the approaches amounted to 240 cubic yards. The total cost of this work was \$17,464.82.

*Installation of water line to coaling plant.*—Upon special authority a permanent water line was installed across the channel to the coaling plant. This work consisted of the laying of 1,939 linear feet of 10-inch extra heavy galvanized pipe, 220 linear feet of 4-inch galvanized pipe for outlets. The excavation for the approaches to channel amounted to 100 cubic yards. The total cost of the work performed was \$6,691.41.

*Installation of water system at Mount Hope oil tank farm.*—Under special authority a water system was installed at the Mount Hope oil tank farm. This consisted of the laying of 2,022 linear feet of 6-inch pipe, 1,856 feet of 4-inch pipe, and 723 linear feet of 3-inch pipe, with the required number of outlets for supply purposes. Total cost, \$2,465.85.

*Galvanized line from gasoline tank No. 27 to Dock No. 13.*—Under special authority 4-inch galvanized line was laid from gasoline tank No. 27 to Dock No. 13, consisting of 2,326 linear feet of 4-inch galvanized pipe, one 4-inch strainer installed, 50 cubic yards of excavation and back fill, and 60 linear feet of 2-inch galvanized pipe for distribution. Total cost, \$1,054.14.

*Grading around fuel-oil tank No. 26.*—Under special authority grading around fuel-oil tank No. 26 was done, the total amount of excavation and fill amounting to 245 cubic yards. Total cost, \$662.95.

*Gravel walk around fuel-oil handling plant at Mount Hope.*—Under special authority a 4-foot gravel walk was constructed around the fuel-oil handling plant at Mount

Hope, consisting of 360 linear feet of curb and gutter placed, and 144 square feet of concrete pavement laid. Total cost, \$198.41.

*Removal of bank in rear of oil-handling plant, Mount Hope.*—Under special authority the bank in the rear of the oil-handling plant at Mount Hope was removed. The excavation at this point amounted to 640 cubic yards. In this connection there were also 353 linear feet of 6-inch sewer pipe laid for drainage purposes. Total cost, \$854.91.

*Grading around employees' quarters, oil-handling plant, Mount Hope.*—Under special authority the grading around the quarters for the employees of the Mount Hope oil-handling plant was done, consisting of 200 cubic yards of excavation, 400 linear feet of curb and gutter placed, 500 square yards of concrete sidewalk laid, and 103 linear feet of 10-inch pipe for drainage purposes laid. Total cost, \$729.03.

*Construction of concrete drains at fuel-oil handling plant.*—Under special authority concrete drains were constructed across the end of the manifold platform of the fuel-oil handling plant. This work consisted of 85 feet of concrete gutter, 18 linear feet of 6-inch vitrified pipe laid, and the necessary excavation and grading. Total cost, \$139.99.

*Water line, Cristobal coaling plant.*—Under special authority an 8-inch water line was laid around the coal pockets at the Cristobal coaling plant. This consisted of the laying of 4,380 linear feet of 8-inch galvanized pipe, 332 linear feet of 4-inch galvanized pipe, the installation of twenty-two 2½-inch fire plugs, and 125 linear feet of 10-inch, 358 linear feet of 2-inch, 716 linear feet of 6-inch, 160 linear feet of 2½-inch, 1,760 linear feet of 2-inch, and 80 linear feet of 1-inch galvanized pipe. In addition to installing the pipes, four 2-inch water meters were installed, and 22 bell boxes around the connections for watering ships. Total cost, \$5,210.50.

*Erection of barbed-wire fence around Mount Hope oil tank farm.*—Under special authority a barbed-wire fence, with concrete posts, was erected around the Mount Hope oil tank farm. This work consisted of 103 concrete posts set, 2,060 linear feet of barbed wire erected, at a total cost of \$2,304.12.

*Construction of barbed-wire fence around gasoline storage tank at Mount Hope.*—Under special authority an overhanging nonclimbable barbed-wire fence was constructed around the gasoline storage tank at Mount Hope. This consisted of the setting of 45 concrete posts, and the erection of 870 linear feet of barbed-wire fence. Total cost, \$431.88.

*Water supply furnished concrete-block mixing plant.*—This consisted of the laying of 560 linear feet of 2-inch galvanized pipe, with necessary connections. Total cost, \$120.97.

*Construction of fire wall around United States oil tank No. 9.*—Under special authority a fire wall was constructed around United States oil tank No. 9. This consisted of 1,500 cubic yards of excavation and fill. Total cost, \$1,041.93.

*Grading and clearing of ground in vicinity of gasoline storage tank No. 27.*—Under special authority the ground in the vicinity of gasoline storage tank No. 27 was graded and cleared, at a cost of \$196.70.

*Relocation of water line to Cristobal coaling station.*—Under special authority the water line leading to the Cristobal coaling station was relocated for a section of 185 linear feet, at a cost of \$238.52.

#### SUPPLY DEPARTMENT.

*Installation of Grinnell sprinkling apparatus for fire protection, Cristobal commissary.*—This consisted of the purchase of 98 Grinnell sprinkler heads, the laying of 830 linear feet of 4-inch galvanized pipe, and 1,500 linear feet of 1½-inch galvanized pipe, at a cost of \$1,174.66.

*Construction of road to Cristobal slaughter house.*—This consisted of the laying of 600 linear feet of curb and gutter, 30 cubic yards of fill for subgrade, 345 square yards of macadam road constructed, and 105 square yards of concrete walk laid. Total cost, \$1,014.64.

*Construction of concrete paving in cattle lanes from cattle pen to Mount Hope Road.*—This work consisted of the laying of 1,782 square yards of pavement and the construction of 400 linear feet of concrete drain, at a total cost of \$674.38.

*Placing of concrete floor in stock pen on E Street, Colon.*—This necessitated the laying of 460 square yards of concrete floor, with the necessary grading, at a total cost of \$292.37.

*Water and sewer connections to New Cristobal Hotel.*—This necessitated the laying of 300 linear feet of 8-inch vitrified pipe, with 40 cubic yards of excavation and back fill.

## PANAMA RAILROAD.

*Removal of refuse in the vicinity of fire station to lots in rear of Panama Railroad stables.*—This work consisted of the loading and transporting of 92 wagonloads of refuse, at a total cost of \$212.81.

*Construction of 16-foot roadway from Eleventh Street to Bolivar Street on west side of Masonic Temple, Cristobal.*—This consisted of the laying of 340 linear feet of curb and gutter, the placing of 302 square yards of macadam roadway, and 15 square yards of concrete pavement, including the necessary grading. Total cost, \$512.71.

*Construction of temporary road, terminal office building, Cristobal.*—This work consisted of the placing of 337 square yards of macadam, with ordinary earth ditches, and one rolled crossing. Cost, \$406.22.

## MISCELLANEOUS.

In addition to the construction work listed, there was approximately \$82,000 worth of work done by the municipal division in the Northern District on blanket work requests from other divisions, these requests amounting to \$1,000 and less for divisions of The Panama Canal, the Panama Railroad, and for private parties.

The number of ships furnished with water at Cristobal during the year, with the total quantity of water furnished, is shown by the following statement:

Class of shipping.	Number of vessels.	Gallons of water.
Foreign shipping.....	748	31,716,693
Panama Canal colliers.....	4	1,071,105
Panama Railroad boats.....	11	1,726,966

The regular municipal maintenance work in the Northern District during the year included the care of the following:

	Colon.	Gatun.	Cristobal.	Mount Hope and vicinity.
Macadam road.....square yards..	150,770	28,560	34,907	65,700
Curb and gutter.....linear feet..	106,256	4,000	35,000	2,000
Brick paving.....square yards..	5,885			
Drains.....linear feet..	6,030	3,000	3,750	
Sewers.....do..	47,285	25,050	13,985	2,000
Water lines.....do..	60,645	22,075	25,510	10,710
Water main to Margarita.....do..				26,000
20-inch main, Brazos Brook to Mount Hope.....do..				13,000
20-inch main, Mount Hope to Colon.....do..				7,830

In the City of Colon all streets and water and sewer lines were maintained and the sewage pumping station was operated throughout the year. The report of the plumbing inspector in this district for the year is as follows:

Plumbing permits issued during the year.....	495
Final certificates issued during the year.....	496
Plumbing permits outstanding June 30, 1916.....	48

The report of the water-collection office for the City of Colon for the fiscal year is given in the following statement:

## REPORT OF WATER-COLLECTION OFFICE, COLON.

*Consumption of water.*

Quarter ending	Number of paying connections.	Consumption of water per quarter.				Total consumption.	Average daily consumption.
		Private connections.	Panama Railroad reservation	Panama Canal hospital and quarantine.	Public fire hydrants and taps.		
		<i>Gallons.</i>	<i>Gallons.</i>	<i>Gallons.</i>	<i>Gallons.</i>	<i>Gallons.</i>	<i>Gallons.</i>
Sept. 30, 1915.....	736	46,740,000	4,949,250	10,352,250	121,648,325	183,689,825	2,040,998
Dec. 31, 1915.....	800	50,936,500	4,577,250	14,394,750	95,081,525	164,990,025	1,833,222
Mar. 31, 1916.....	848	52,732,500	3,632,250	10,351,500	96,645,575	163,361,825	1,815,131
June 30, 1916.....	883	55,381,000	3,567,750	10,196,250	92,800,725	161,945,725	1,799,396
Total for year.....		205,790,000	16,726,500	45,294,750	406,176,150	673,987,400	1,872,187

<sup>1</sup> Average.

*Water rental collections.*

Quarter ending	Amount collected from private consumers.	Amount collected from Panama Railroad.	Amount collected from Panama Canal.	Amount paid or to be paid by the Panama Government.	Total revenue per quarter.	Average consumption per quarter per connection.	Average private quarterly bill.	Average cost per hydrant.
						<i>Gallons.</i>		
Sept. 30, 1915.	\$18,925.50	\$1,484.40	\$3,106.20	\$11,562.57	\$35,078.67	63,505	\$25.71	\$101.42
Dec. 31, 1915.	20,896.30	1,373.40	4,318.50	11,789.13	38,377.33	63,670	26.12	103.41
Mar. 31, 1916.	21,414.00	1,090.20	3,105.90	9,647.54	35,257.64	62,184	25.25	84.63
June 30, 1916.	22,467.00	1,070.40	3,059.40	(1)	26,596.80	62,719	25.44	.....
Total for year. ....	83,702.80	5,018.40	13,590.00	32,999.24	135,310.44	252,078	102.52	289.46

<sup>1</sup> The amount to be paid by the Panama Government depends upon the cost of maintenance and other charges, and can not be determined for quarter ending June 30, 1916, at date this report is submitted.

## OPERATION OF WATER PURIFICATION PLANTS.

The following report of the operation of the purification plants, inspection of the reservoirs, and the laboratory control of the water supplies in the Canal Zone has been submitted by Mr. George C. Bunker, physiologist:

## MOUNT HOPE PURIFICATION PLANT.

This plant, in operation since February 23, 1914, supplies filtered water to that portion of the Northern District which lies north of Mount Hope, and includes Colon, Cristobal, Margarita Island, and Mount Hope, with a combined population of about 37,000. The plant comprises the following units: Aeration basin, sedimentation basin, rapid sand filters, clear-water basin, and chlorinator.

*Aeration basin.*—This basin, measuring 60 by 66 feet, is equipped with 85 cone nozzles, which are arranged in five batteries of 17 each. The nozzles are so adjusted that, under ordinary operating conditions, the raw water is discharged at an angle of 30 degrees in a thin sheet which breaks up into fine drops. The average diameter of the circle which would be formed by the discharge of one nozzle striking the floor would be 24 feet. The average loss of head due to the nozzle itself is 1.95 feet. The following figures furnish a typical illustration of the action of the nozzles:

Source of sample.	Temperature.	Dissolved oxygen.		Carbon dioxide, parts per million.
		Parts per million.	Per cent saturation.	
Raw-water tap.....	28.8° C.	5.09	65.2	2.5
Discharge from aeration basin.....	28.0° C.	7.38	93.1	0.0

With the nozzles adjusted for the maximum flow of water the latter is discharged in the form of a sheet of varying thickness without any spraying. Under these conditions the average diameter of the circle which would be formed by the discharge of one nozzle striking the floor would be 10 feet. The average loss of head due to the nozzle itself is 0.5 foot. The amount of oxygen added to the water and the amount of carbon dioxide removed is practically the same under these conditions.

Source of sample.	Temperature.	Dissolved oxygen.		Carbon dioxide, parts per million.
		Parts per million.	Per cent saturation.	
Raw-water tap.....	29.5° C.	4.37	56.7	3.5
Discharge from aeration basin.....	29.2° C.	6.76	87.2	1.5

With increased amounts of carbon dioxide in the raw water a better reduction is effected by a spraying action of the nozzles. The removal of disagreeable odors is also more efficient. An odor of hydrogen sulphide of a numerical value of 5 (Whipple's scale) is completely removed by the spraying action of the nozzles.

The following table, arranged by months, shows the reduction in free carbonic acid effected by the aeration:

*Free carbonic acid.*

Month.	Raw water.				Aerated water.			
	Median.	Mean.	Maximum.	Minimum.	Median.	Mean.	Maximum.	Minimum.
1915.								
July.....	3.0	3.0	5.0	1.0	1.0	1.0	5.0	0
August.....	1.0	0.7	1.0	0.0	0.5	0.3	0.5	0
September.....	0.5	0.8	3.0	0.0	0.0	0.2	0.5	0
October.....	3.0	2.7	4.0	0.0	1.0	0.8	2.0	0
November.....	2.0	2.3	4.0	1.0	0.5	0.7	1.0	0.5
December.....	2.0	2.3	6.0	0.0	0.5	0.6	1.0	0
1916.								
January.....	1.0	1.3	5.0	0.5	0.5	0.4	1.5	0
February.....	1.0	0.8	1.0	0.0	0.0	0.0	0.0	0
March.....	2.5	2.6	4.5	0.5	0.5	0.5	1.0	0
April.....	2.5	2.6	4.5	1.0	0.0	0.1	0.5	0
May.....	1.5	1.7	4.5	0.0	0.0	0.1	0.5	0
June.....	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0

<sup>1</sup> Carbonate alkalinity.

The addition of free carbonic acid due to the use of alum, varying from 106 to 317 pounds per million gallons, increased the final content of the filtered water to 3 to 8 parts.

Table No. 16, Physical and Chemical Character of Raw and Filtered Water, Mount Hope Purification Plant, contains the results of the dissolved oxygen determinations which have been made at least once each week as a routine procedure. The raw-water content has varied from 1.75 parts per million (22.2 per cent saturation) when the bottom intake, 25 feet below the surface, was in use, to 9 parts (119 per cent saturation) when the surface intakes were in use. In the former case the effect of the aeration was to increase the dissolved oxygen to 7.15 parts, or 90 per cent saturation. In the latter case there was a reduction to 7.76 parts, or 101 per cent. On August 9, 1915, and November 20, 1915, the nozzles reduced the dissolved oxygen from 8.04 and 8.38 parts (105 and 107 per cent saturation) to 7.96 and 7.93 parts (102 and 100 per cent saturation).

The variation in the dissolved oxygen content of the raw, aerated, settled, and filtered water during a 24-hour period is shown by a set of determinations made by Mr. C. H. Spaulding. At this time water was being drawn from the surface of the reservoir.

Time.	Raw water.		Aerated water.		Settled water.		Filtered water.	
	Parts per million.	Per cent saturation.	Parts per million.	Per cent saturation.	Parts per million.	Per cent saturation.	Parts per million.	Per cent saturation.
<i>Jan. 7, 1916.</i>								
Midnight.....	7.69	98.8	7.67	97.5	7.87	101.0	7.77	100.1
3 a. m.....	7.62	98.1	7.63	97.5	7.75	99.3	7.70	98.8
6 a. m.....	7.55	97.0	7.63	97.0	7.68	98.0	7.59	97.0
7 a. m.....	7.48	96.0	7.66	97.0	7.68	98.0	7.59	97.0
8 a. m.....	7.48	96.5	7.77	99.0	7.68	97.7	7.46	95.0
9 a. m.....	7.58	98.3	7.80	100.0	7.77	99.0	7.55	96.1
10 a. m.....	7.65	99.3	7.77	99.9	7.77	99.2	7.55	96.3
11 a. m.....	7.83	102.4	7.70	99.9	7.81	99.2	7.64	97.6
Noon.....	7.48	97.5	7.73	99.6	7.91	101.3	7.64	97.7
1 p. m.....	7.62	99.5	7.77	100.5	7.96	102.3	7.68	98.4
2 p. m.....	7.69	100.5	7.77	100.5	8.09	104.0	7.77	99.9
3 p. m.....	7.65	99.9	7.70	99.6	8.00	103.3	7.73	99.4
4 p. m.....	7.55	98.1	7.77	100.0	8.00	103.3	7.73	99.5
5 p. m.....	7.69	99.6	7.77	99.7	7.81	100.4	7.64	98.2
6 p. m.....	7.83	101.3	7.74	98.8	7.96	102.4	7.91	101.6
7 p. m.....	7.90	101.6	7.83	99.9	8.05	103.4	7.91	101.5
9.30 p. m.....	7.48	95.9	7.67	97.6	8.00	102.6	7.81	100.0
Midnight Jan. 8.....	7.33	93.8	7.60	96.2	7.87	100.5	7.73	98.8

The variations in temperature and free carbonic acid during the same period are shown below:

Time.	Temperature.				Free carbonic acid.			
	Raw.	Aerated.	Settled.	Filtered.	Raw.	Aerated.	Settled.	Filtered.
<i>Jan. 7, 1916.</i>								
Midnight.....	28.7	28.1	28.5	28.8	0.5	0	7.0	7.0
3 a. m.....	28.8	28.3	28.5	28.5	0.5	0	8.0	8.0
6 a. m.....	28.7	28.1	28.3	28.3	0.5	0	8.5	8.5
7 a. m.....	28.6	27.9	28.3	28.3	0.5	0	9.0	9.0
8 a. m.....	28.9	28.2	28.1	28.2	0.5	0	8.5	8.5
9 a. m.....	29.2	28.6	28.2	28.2	0.5	0	8.5	8.5
10 a. m.....	29.3	28.8	28.3	28.3	0.0	0	8.5	8.5
11 a. m.....	29.6	29.2	28.4	28.4	0.0	0	9.0	9.0
Noon.....	29.4	28.8	28.4	28.4	0.5	0	9.0	9.0
1 p. m.....	29.6	29.0	28.6	28.55	0.5	0	9.0	9.0
2 p. m.....	29.6	29.0	28.7	28.7	0.5	0	9.0	9.0
3 p. m.....	29.5	29.0	28.8	28.7	0.5	0	9.0	9.0
4 p. m.....	29.2	28.7	28.8	28.7	0.5	0	9.0	9.0
5 p. m.....	29.0	28.5	28.7	28.7	0.5	0	9.0	9.0
6 p. m.....	28.9	28.3	28.7	28.7	0.5	0	8.5	8.5
7 p. m.....	28.7	28.2	28.7	28.7	0.5	0	9.0	9.0
9.30 p. m.....	28.6	28.2	28.5	28.5	1.0	0	9.0	9.0
Midnight Jan. 8.....	28.4	27.9	28.4	28.4	1.0	0	9.0	9.0

The settled-water samples were collected from the influent to one of the filters, and the filtered water was collected from the controller box of the same filter.

*Alum.*—The alum solution is added to the water as it leaves the aeration basin by an orifice box. The water then passes through three baffled mixing chambers and discharges into the sedimentation basins.

*Sedimentation basins.*—There are three cross-connected parallel concrete sedimentation basins, with a total capacity of 2,500,000 gallons. The length of each basin is 171 feet, the combined width of the three is the same, the depth at the floor valleys is 13 feet 6 inches, and that at the summits 12 feet 3 inches. Each basin is divided into three compartments, 56 feet 8 inches square, by two pressure baffle walls, which are provided with four rectangular openings 1 foot wide by 4 feet long, placed 3.5 feet below the water level. Extending across these baffle walls in front of the openings there are concrete skimming troughs which reach to within about a foot of the normal water level. Between the pressure walls there is a light baffle wall in each compartment which extends from one side to within 6.5 feet of the opposite side, thus leaving an opening 13.5 feet deep and 6.5 feet wide through which the water passes on its course from one compartment to the next.

By means of weirs in the two divisional walls at the inlet end the three basins may be operated as one large basin, water passing from one to the other. Each basin is also equipped with gates at the outlet end so that any one may be thrown out of service for cleaning.

Experience has shown that in order to eliminate a multiplication of harmless bacteria in these basins it is necessary to drain and wash the first section of each—that is, the sections into which the aerated water first passes—once a week. Due to the formation of a coarser floc than in similar waters in the States, at least 75 per cent of the coloring matter and aluminum hydrate deposits in these sections. Every 30 days it is necessary to drain and wash the entire basin, as at the end of this time or earlier small cakes of sludge, 4 to 6 inches thick, will be carried to the top of the water by the gas which has formed by septic action. The predominant odor during the cleaning of the basins is that of boiled cabbage. At times these cakes of sludge will begin to float to the top in less than 30 days after the last cleaning, and if the basins are not drained and cleaned immediately a multiplication of bacteria results in the settled waters.

In addition, it has been found that the bacteria in the settled water run higher at times during the early morning, when the water from the reservoir is slightly colder than the water in the basins and consequently sinks to the bottom, displacing some of the lower water which contains more bacteria and forcing it to the top, with the result that the settled water taken from the top layers will contain more bacteria than the inflowing raw settled water.

The percentages of water wasted by cleaning the basins during the fiscal year have run from 1.74 to 6.46, averaging 4.5 during the last four months, when the first three sections have been regularly cleaned on Monday, Tuesday, and Wednesday of each week. During June, 1916, when 4.71 per cent of water was wasted, the aver-

age number of colonies of bacteria in the raw and settled water, on nutrient agar at 37.5° C., were 301 and 169 per c. c., respectively.

At the filter building end of the basins the top layers of the settled water are drawn off by skimming platforms and enter a receiving box, from which it passes upon the filters through two 22-inch cast-iron pipes.

*Rapid sand filters.*—There are six rapid sand gravity filters, constructed of reinforced concrete, measuring 27.5 by 18.66 feet and 10.25 feet deep to the floor, on which the underdrainage system is placed. They are arranged in two rows of three units each, with the operating floor and pipe gallery between. Each unit has a sand area of 513 square feet, or 0.01178 of an acre. Operated at the present rate of 104,200,000 gallons per acre per day, each unit delivers 1,226,000 gallons per 24 hours.

Embedded in the floor is an underdrainage system of the Harrisburg, Pa., type, composed of parallel 2-inch galvanized pipes, 4 feet long, spaced 6 inches apart, and perforated on the undersides with holes seven-thirty-seconds inch in diameter, which are spaced 3 inches apart. Each of the two manifolds is tapped with a 4-inch air line.

In each filter there are 22 inches of Chagres River gravel, arranged in three layers, as follows:

Layer.	Thickness.	Size.
	<i>Inches.</i>	
Bottom.....	8	Passed by 14-inch square mesh; retained on 1-inch square mesh.
Middle.....	12	Passed by 1-inch square mesh; retained on ½-inch square mesh.
Top.....	2	Between ¼ and ⅜ inch diameter.

Thirty inches of Chame beach sand, with an average effective size and uniformity coefficient of 0.41 and 1.70, respectively, complete the filtering material.

In washing, the filtering material is first loosened by applying a small amount of wash water at a low rate. Air is then applied for a period of four to five minutes. It has been found that scouring of the sand by air is very important at this plant in order to prevent the formation of an excessive number of mud balls, as the low-velocity water wash is insufficient in itself to prevent their formation. In addition the air wash freshens the sand and gravel by forcing out the odors which accumulate during a filter run. Water is then applied at the rate of 5,900 to 6,000 gallons per minute, or 11.1 gallons per square foot of sand surface, equivalent to a 17.5-inch vertical rise per minute. The sand bed is lifted 2.5 inches above its normal elevation. The wash water is removed by one central and eight lateral concrete troughs.

Each filter is operated by hydraulic valves controlled from an operating table, each of which, in addition to the usual equipment, is provided with small 10-watt green and red lamps, so connected that the former burns when the filter is in operation and the latter starts to burn when the loss of head reaches a fixed point.

The discharge of filtered water from each filter is regulated by a controller, which consists of a concrete box, rectangular in shape and measuring 7 by 5 feet in plan by 3 feet deep, cast on the floor of the pipe gallery; a circular bronze orifice cast in the floor and opening into the clear-water basin; and a copper float 3.5 feet in diameter, which actuates a piston valve 24 inches in diameter. By adjusting this float the discharge from each unit may be varied from 1,132,000 to 1,386,000 gallons per 24 hours, at the respective rates of 94,600,000 to 117,800,000 gallons per acre per day.

The following table summarizes the data relating to the filters:

Number of units.....	6
Sand area per unit, square feet.....	513
Dimensions of unit:	
Length in feet.....	27.5
Width in feet.....	18.66
Depth.....	10.27
Wash-water troughs:	
Type.....	(1)
Number.....	(2)
Thickness of concrete, inches.....	2.5
Dimensions—	
Main trough, feet.....	27.5 by 2.73
Lateral troughs.....	8.12 by 1.41
Per cent of sand area covered by horizontal area of troughs.....	32
Average distance above sand, inches.....	24

<sup>1</sup> Reinforced concrete.

<sup>2</sup> 1 main and 8 laterals.

Washing of filters:	
Type.....	(1) 4
Average minutes of air.....	4
Vertical rise of water per minute, inches figured on area below troughs..	17.5
Vertical rise of water per minute, inches figured on area at plane of troughs..	25.75
Gallons of water per minute.....	5,950
Gallons of water per square foot of sand surface per minute.....	11.1
Sand bed lifted above normal, inches.....	2.5
Loss of head through filter, feet.....	16.5
Maximum travel of suspended particles, feet.....	2.7
Depth of water over edges of troughs.....	1.9
Filter bottom:	
Type.....	(2)
Manifolds, number.....	2
Laterals—	
Number.....	216
Spaced, center to center, inches.....	6
Length, feet.....	4
Size.....	(3)
Size of holes, inches.....	$\frac{7}{32}$
Number of holes.....	3,672
Relation between area of holes in laterals and the sand surface of 1 filter.....	<sup>4</sup> 1 to 530
Filtering material:	
Sand—	
Source.....	(5)
Depth, inches.....	30
Effective size.....	0.41
Uniformity coefficient.....	1.70
Gravel—	
Depth—	
Bottom layer, inches.....	8
Middle layer, inches.....	12
Top layer, inches.....	2
Size—	
Bottom layer, inches.....	$1\frac{1}{3}$ to 1
Middle layer, inches.....	$\frac{5}{8}$ to $\frac{1}{2}$
Top layer, inches.....	$\frac{1}{4}$ to $\frac{1}{8}$
Operation:	
Loss of head—	
Average initial, feet.....	1.3
Average final, feet.....	12.3
Normal depth of water over sand, feet.....	5.75

<sup>1</sup> Combined low-velocity water and air.<sup>2</sup> Perforated pipes, Harrisburg (Pa.) type.<sup>3</sup> 2-inch nominal diameter galvanized-iron pipe.<sup>4</sup> Or 0.18 per cent.<sup>5</sup> Chame beach.

*Clear-water basin.*—This basin is located under the filter building and has a capacity of 520,000 gallons.

*Chlorinator.*—A chlorinator was installed in the latter part of February, 1916. Liquid chlorine is applied to the filtered water as it flows from the clear-water basin to the well in the pump station. Due to the present arrangement of the piping, the water with which the wash-water tank is filled does not pass through the Venturi meter which controls the chlorinator, with the result that the filtered water going both to the tank and the mains is undertreated. The changes necessary to correct this are under way.

*Bacteriological data.*—Tables Nos. 8 and 11, inclusive, marked as follows: Table No. 8, Numbers of Colonies of Bacteria in Raw Water; Table No. 9, Numbers of Colonies of Bacteria in Water Delivered to Mains; Table No. 10, Numbers of Colonies of Bacteria in Samples from Taps on Distribution System; and Table No. 11, Numbers of Members of the B. Coli Group, contain monthly summaries of the bacteriological examinations of samples of water made throughout the year. The above tables are based on the forms recommended by the "Committee on Statistics of Water Purification" of the New England Water Works Association, with some changes to suit local conditions.



The following quotations are taken from the report of the above committee which was presented on January 13, 1915:

"By the term 'test day' is meant a period of 24 hours during which tests are made."

"Each monthly average, or mean, should be obtained by dividing the sum of the daily results by the number of days on which tests were made during the month, that is, by the number of test days."

"\_\_\_\_\_, and also for the sake of simplicity, the committee recommends that the annual average be taken as the mean of the 12 monthly averages."

"The occurrence of occasional observations which are abnormally high often causes the average to be non-representative of the tests made during a month or year. Sometimes a single erratic test will greatly distort the average result. For this reason the median as well as the mean should be computed for each month and year."

"Literally, the median is the result which lies in the middle of a series of results arranged in order from lowest to highest. That is, it is that value above and below which are an equal number of higher and lower values. \_\_\_\_\_ To find the monthly median, arrange the daily results obtained during the month in order of magnitude. If there is an odd number of tests, select the middle term. If there is an even number, take as the median the average of the two middle terms. To find the yearly median, arrange the daily results for the entire year in order of magnitude, regardless of the month in which they occur. Do not take the average of the monthly median, or even the median of the monthly medians."

"The B. coli index is the approximate number of B. coli per c. c., as determined from qualitative tests made upon the different quantities of water. For any individual sample, it may be taken as the reciprocal of the smallest volume of water used in the test which gave a positive result. Thus if a sample gave a negative test with 0.1 c. c., and a positive test with 1.0 c. c. and 10 c. c., the B. coli index would be  $1-0.1=10$ . The B. coli index for a single sample is not very accurate. The index becomes more and more precise as the square root of the number of tests becomes larger."

"The B. coli index may be computed from a series of results as follows:"

"Write down the percentages of positive tests for the given quantities examined, expressed as decimals of 100."

"Take the differences between these percentages."

"Multiply each of these differences by the reciprocal of the quantity corresponding to the larger of the two percentages from which such differences was taken."

"The sum of these products will be the B. coli index."

The following table contains the yearly means and medians of the numbers of colonies of bacteria in the raw and filtered water as determined on nutrient and lactose agar incubated at 37.5° C. for 24 hours. They are taken from Tables Nos. 8 to 10, mentioned above.

Source.	Nutrient agar.		Lactose agar.	
	Yearly mean per c. c.	Yearly median per c. c.	Yearly mean per c. c.	Yearly median per c. c.
Raw water.....	1,173	380	110	91
Water delivered to mains.....	426			
Water from taps on distribution system.....	486	325	44	8
	517	205	39	11

<sup>1</sup> Omitting 16 abnormal counts above 1,000 per c. c. in October, due to copper sulphate treatment, the yearly mean is reduced to 426 per c. c.

In general, the numbers of colonies of bacteria in the filtered water samples have exceeded those in the raw and settled water samples. This was due partly to a multiplication of bacteria in the water in passing through the sedimentation basins, but principally to a multiplication in the filters, which started in December, 1914, 10 months after the plant had been in operation, and has continued ever since. Examination of the sand at that time showed that it contained large numbers of small and large mud balls. A bacteriological examination of one of the mud balls, mixed with 100 c. c. of water and thoroughly shaken, showed that there were 35,000 colonies of bacteria per c. c., on nutrient agar at 37.5° C. 24 hours, in the water, or 3,571 per gram of dry sand. Gas developed from both 1 and 10 c. c. of the water inoculated into lactose bile.

During the period from the starting of the plant in February, 1914, to December of the same year, dead microorganisms and organic matter had gradually accumulated in the filters, due to an inefficient air wash and a low velocity water wash. In the latter month a larger air receiver was installed, and the length of the air wash increased to four to five minutes, thereby thoroughly scouring the sand. In January and February, 1916, the sand and fine gravel in all the filters were washed. The longer air wash has largely prevented the formation of mud balls, but with the amount of vegetable matter in the raw water a certain amount of dirt will always accumulate in these filters on account of the low velocity water wash in use.

The multiplication of bacteria in the filters has continued up to the end of the fiscal year because it has been impossible to eliminate the species causing the trouble from the wash water. As long as they are present in the latter, even in small numbers, they will be constantly returned to the filters and act as "starters." One species formed violet colonies on nutrient agar plates developed at 37.5° C. Soon after the use of liquid chlorine was started and partially sterilized wash water became available this species practically disappeared.

During the last three months of the year the numbers of colonies of bacteria in samples of the effluents from the filters have averaged 303 c. c. as compared with 779 per c. c. during the three months prior to the use of partially sterilized wash water. It is expected that eventually the species responsible for the multiplication of bacteria in the filters will be entirely eliminated by washing with sterile wash water.

The monthly averages of numbers of *B. coli* in the raw water varied from 138 to 1,419 per liter, with a yearly average of 805; in the water distributed to the mains, from 0 to 193 per liter with a yearly average of 33; in the water collected from the distribution system, from 3 to 146, with a yearly average of 56. These figures are based on the results of presumptive tests with lactose peptone bile incubated for 48 hours at 40° C. All tests showing less than 20 per cent of gas were considered as negative.

*Physical and chemical data.*—This is summarized in Table No. 16, Physical and Chemical Character of Raw and Filtered Water, Mount Hope Purification Plant. The following determinations are made daily: Odor of raw and filtered water, color of filtered water, turbidity of raw and filtered water, and free carbonic acid of the raw, aerated, settled, and filtered water. The entries in the table under these headings are the weekly averages of the daily determinations. The remaining tests are made once each week on a composite of daily samples.

The apparent color of the raw water varied from 16 to 77 parts. The color of the filtered water varied from 0 to 10 parts. The turbidity of the raw water varied from 0 to 24, of which all was removed by the process of purification. The free carbonic acid of the raw water varied from 0 to 4.2 parts, and during the last four weeks of the year there was a carbonate alkalinity of 1 to 2 parts. In the filtered water the free carbonic acid ranged between 2.0 and 8.1 parts. The alkalinity of the raw water varied from 22 to 44 parts and that of the filtered water from 12 to 35 parts. The soap hardness of the raw water ranged from 19.5 to 38 parts, and that of the filtered water from 20.8 to 31.6 parts. The oxygen consumed of the raw water varied from 1.6 to 5.0 parts, and that of the filtered water from 0.3 to 2.9. The chlorine varied from 4.0 to 6.0 parts. The raw water contained from 0.2 to 1.0 parts of iron, and the filtered water from 0 to 0.25 parts.

*Operative data.*—This is summarized in Table No. 2, Annual Report of Operation of Mount Hope Purification Plant for Fiscal Year Ending June 30, 1916.

The monthly volumes of raw water varied from 120,426,000 to 148,894,000 gallons, with a yearly average of 131,232,000 gallons. The monthly volumes of water delivered to the mains varied from 106,650,000 to 141,270,000 gallons, with a yearly average of 119,002,000 gallons. The monthly volumes of wash water varied from 4,724,000 to 11,326,000 gallons, with a yearly average of 7,435,000 gallons.

The "gallons per filter hour" varied from 49,730 to 57,900 per month, with a yearly average of 52,169. The "million gallons per acre per day" varied from 101,317,000 to 117,960,000 per month, with a yearly average of 106,200,000. The average filter runs per month varied from 12.3 to 29.3, with a yearly average of 18.9 hours. The maximum filter run per month varied from 17.3 hours in February, 1916, to 60.8 hours, and 60.7 hours in October and November, 1915. The maximum runs followed as a result of the treatment of Brazos Brook Reservoir with copper sulphate, at the rate of 5 pounds per million gallons, on October 14.

The "number of filters washed" varied from 105 in November to 230 in October, 1915, with a yearly average of 148. The "per cent of wash water" varied from 3.24 in July to 8.87 in October, 1915, with a yearly average of 5.88.

The pounds of alum consumed per month varied from 15,343 in September, 1915, to 42,553 in February, 1916, with a yearly average of 26,298, and a total of 315,571 pounds. The pounds per million gallons varied from 106 to 347 for the above months, with a

yearly average of 200. The parts per million of available chlorine applied to the filtered water varied from 0.115 to 0.137 in the last three months of the year.

*Superintendence.*—The resident chemists during the year were Messrs. C. H. Spaulding and Harry T. Campion.

#### AGUA CLARA PURIFICATION PLANT.

This plant, in operation since December 29, 1911, supplies filtered water to Gatun, with a population of about 1,900. The plant comprises the following units: Mixing chamber, sedimentation basin, rapid sand filters, and clear-water basin.

*Mixing chamber.*—The reinforced concrete mixing chamber measures 5 by 30.5 feet in plan. Eight vertical baffles, forming alternate submerged and overfall weirs, insure a thorough mixing of the raw water with the alum solution, which is added through a perforated pipe at the inlet end. Ineffective aeration of the water is obtained by forcing compressed air into it as it passes through this chamber.

*Sedimentation basin.*—This basin measures 70.5 by 71 feet in plan (inside measurements) by 10.5 feet in depth. Its capacity is 350,000 gallons. A pressure wall separates it into two divisions of equal size, thus forming two basins, which are operated in parallel. Each division is further subdivided by a baffle wall into two compartments, each of which measures 35 by 35 feet in plan. Each baffle wall is provided with three rectangular openings, 1 foot wide by 5 feet long, placed 3.5 feet below the water level. Extending across these baffle walls in front of the openings there are skimming troughs, which reach to within 20 inches of the normal water level. Each basin is equipped with gates at the inlet and outlet ends, so that either one may be thrown out of service for cleaning.

During the latter part of the year an experimental wooden baffle was placed in each of the compartments, into which the water first passes after leaving the mixing chamber. This was done with the idea of breaking up some of the short-circuiting currents and insuring more efficient sedimentation. After further experiments as to the size and most suitable position permanent concrete baffles will be built.

Due to the extraordinary multiplication of harmless bacteria in these basins it has been found necessary to drain and wash the entire basin each week. Even this procedure does not eliminate the multiplication, as is shown in the following table, made up of monthly averages, maxima and minima, of numbers of colonies of bacteria in the raw and settled water, from September, 1914, to June, 1916, as determined on nutrient agar incubated at 37.5° C. for 24 hours.

Month.	Raw water.			Settled water.		
	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.
1914.						
July.....	458			393		
August.....	293			1,880		
September.....	241	390	104	1,630	5,000	87
October.....	158	288	64	845	2,760	5
November.....	3,710	19,000	40	518	2,500	4
December.....	2,620	15,000	40	147	1,110	7
1915.						
January.....	38	140	9	109	465	7
February.....	567	3,000	3	367	2,950	1
March.....	152	850	30	51	340	11
April.....	217	610	12	90	310	8
May.....	246	438	130	707	10,000	14
June.....	180	400	85	470	1,300	16
July.....	248	665	86	170	463	43
August.....	309	650	144	335	1,950	32
September.....	234	465	60	272	1,330	18
October.....	385	3,500	48	239	725	36
November.....	530	1,050	285	395	1,300	19
December.....	410	860	150	324	1,050	56
1916.						
January.....	230	360	70	906	5,200	52
February.....	556	950	265	545	2,400	84
March.....	517	1,190	140	393	1,640	50
April.....	322	1,330	74	617	3,400	70
May.....	678	1,860	190	1,370	9,500	70
June.....	634	5,150	200	2,207	17,500	125

On November 16, 1914, and February 16, 1915, copper sulphate was applied to the reservoir at the rate of 4 pounds per million gallons. The large increase in bacteria in the raw water during the months of November and December, 1914, and February, 1915, was due to these treatments. The copper sulphate was applied with the idea that perhaps the large increase of bacteria in the raw water would overcome the species which were multiplying in the sedimentation basins. That these treatments were of some benefit is shown by the reduction in bacteria in the settled water in the months of March and April, 1915. However, in the succeeding months the multiplication again started and has continued up to the present time.

In general the bacteria start to increase the first day after the basins have been cleaned. The following table covering a period of 13 weeks from April 1 to June 30, 1916, during which period the basins were cleaned once a week, illustrates the multiplication of bacteria during the seven-day periods after cleaning:

*Number of colonies of bacteria on nutrient agar.*

	Number of days after cleaning.						
	1	2	3	4	5	6	7
Raw water entering north basin:							
Average.....	238	459	553	881	617	421	465
Median.....	250	350	500	400	450	310	400
Settled water from north basin:							
Average.....	279	1,570	1,220	1,270	1,210	1,620	1,474
Median.....	210	665	950	1,140	720	675	1,000
Raw water entering south basin:							
Average.....	459	553	881	617	421	465	354
Median.....	350	500	400	450	310	400	250
Settled water from south basin:							
Average.....	279	1,570	1,220	1,270	1,210	1,620	1,474
Median.....	210	665	950	1,140	720	675	1,000

On account of leaky gates it is impossible to prevent water running from the basin in use to the one being cleaned, as a result of which the clean basin is always seeded with the bacteria which multiply so rapidly. It is impracticable to shut down the entire plant once a week so that both basins may be cleaned at once. Up to the present time the method of eliminating the multiplication of bacteria in these basins has not been found, but it is expected that further studies will solve the problem.

The percentages of water wasted by cleaning the basins during the fiscal year have run from 4.8 to 8.58, with a yearly average of 6.54.

At the filter building end of the basins the settled water enters a receiving box from which it passes upon the filters through a 16-inch cast-iron pipe.

*Rapid sand filters.*—There are four rapid sand gravity filters, constructed of reinforced concrete, measuring 17 feet square by 9 feet deep to the floor, on which the underdrainage system is placed. They are arranged in two rows of two units each, with the operating floor and pipe gallery between. Each unit has a sand area of 279 square feet, or 0.0066 of an acre. If operated at a rate of 98,000,000 gallons per acre per day each unit will deliver 646,800 gallons per 24 hours.

During the first half of the fiscal year these filters were overhauled; the work consisting of removing and cleaning the laterals, changing the air system, replacing the steel wash-water troughs with larger ones of concrete, and rearranging the gravel and sand. At present the interior equipment of the filters is as described below.

Embedded in the floor is an underdrainage system of the Harrisburg (Pa.) type, composed of parallel 2-inch galvanized pipes, 4 feet long, spaced 6 inches apart, center to center, and perforated on the water sides with holes seven thirty-seconds of an inch in diameter, which are spaced on 3-inch centers.

A 4-inch air line is laid along the center line of the filter, 1 foot 9 inches above the floor. Three 2-inch lines lead from the main air line to each of the two manifolds, and are tapped into the latter at three points equally distant from each other and the ends of the filters, so as to insure as even a distribution of the air as possible.

In each filter there are 24 inches of Chagres River gravel, arranged in three layers, as follows:

Layer.	Thick- ness.	
	<i>Inches.</i>	
Bottom.....	8	Passed by 1½-inch square mesh. Retained on 1-inch square mesh.
Middle.....	12	Passed by 1-inch square mesh. Retained on ¾-inch square mesh.
Top.....	4	Between ⅞ and ⅞ inch diameter.

Thirty inches of Chame Beach sand, with an average effective size and uniformity coefficient of 0.44 and 1.81, respectively, complete the filtering material.

Previous to the air wash the filtering material is loosened by a small amount of wash water, so as to obtain a better distribution of air. A larger air receiver was also installed at this plant during the year in order to provide an air wash of four to five minutes. As at the Mount Hope purification plant, it has been found that scouring of the sand by air is very important in preventing the formation of an excessive amount of mud balls. After the air wash, water is applied at the rate of 3,800 gallons per minute, or 13 gallons per square foot of sand surface, equivalent to a 21-inch vertical rise per minute. The sand is lifted 3 inches above its normal elevation. The wash water is removed by two parallel concrete troughs.

Each filter is equipped with hand-operated valves and a loss-of-head gage. The discharge from each filter is regulated by a controller. By the use of circular plates of different diameters the rate of filtration may be varied from 60,000,000 to 98,000,000 gallons per acre per day.

The following table summarizes the data relating to the filters:

Number of units.....	4
Sand area per unit, square feet.....	289
Dimensions of unit:	
Length, in feet.....	17
Width, in feet.....	17
Depth, in feet.....	9
Wash-water troughs:	
Type.....	( <sup>1</sup> )
Number.....	2
Thickness of concrete, inches.....	2.5
Dimensions of each—	
Length, in feet.....	16.91
Width, in feet.....	1.91
Per cent of sand area covered by horizontal area of troughs.....	22.3
Average distance above sand, inches.....	22
Washing of filters:	
Type.....	( <sup>3</sup> )
Average minutes of air.....	4-5
Vertical rise of water per minute, inches, figured on area below troughs.....	21
Vertical rise of water per minute, inches, figured on area at plane of troughs.....	27.1
Gallons of water per minute.....	3,800
Gallons of water per square foot of sand surface per minute.....	13
Sand bed lifted above normal, inches.....	3
Loss of head through filter, feet.....	13.8
Maximum travel of suspended particles, feet.....	3.25
Depth of water over edges of troughs, inch.....	1
Filter bottom:	
Type.....	( <sup>4</sup> )
Manifolds, number.....	2
Laterals—	
Number.....	124
Spaced, center to center, inches.....	6
Length, feet.....	4
Size.....	( <sup>5</sup> )
Size of holes, inches.....	$\frac{7}{32}$
Number of holes.....	2,176
Relation between area of holes in laterals and the sand surface of one filter.....	<sup>6</sup> 1 to 509

<sup>1</sup> Reinforced concrete.

<sup>2</sup> Parallel.

<sup>3</sup> Combined low velocity, water and air.

<sup>4</sup> Perforated pipes (Harrisburg, Pa., type).

<sup>5</sup> Two-inch nominal diameter, galvanized-iron pipe.

<sup>6</sup> Or 0.19 per cent.

## Filtering material:

## Sand—

Source.....	( <sup>1</sup> )
Depth, inches.....	30
Effective size.....	0.44
Uniformity coefficient.....	1.81

## Gravel—

## Depth—

Bottom layer, inches.....	8
Middle layer, inches.....	12
Top layer, inches.....	4

## Size—

Bottom layer, inches.....	1½ to 1
Middle layer, inches.....	1 to ¾
Top layer, inches.....	¾ to ⅝

## Operation:

## Loss of head—

Average initial, feet.....	0.6
Average final, feet.....	7.5
Normal depth of water over sand, feet.....	4.16

## 1 Chame Beach.

*Clear-water basin.*—The controllers discharge into a cast-iron pipe, which in turn discharges into a covered concrete clear-water well, which is located a short distance from the filter building, and has a capacity of 225,000 gallons.

*Chemical treatment.*—The continual low alkalinity of the raw-water supply of this plant, 14 to 20 parts per million, with the amount of alum necessary for the removal of the color, which has varied from 30 to 110 parts during the fiscal year, have produced conditions such that it was considered advisable and necessary to increase the alkalinity and decrease the amount of free carbonic acid in the filtered water by the addition of soda ash or lime. The application of the former chemical was started in the early part of February. The use of settled water with zero alkalinity and, at times, an alum acidity caused a shortening of the filter runs to about four hours, a cementing together of the sand, with the formation of hard spots in the filters, a marked corrosive action on service pipes, and—most important of all—a harmful physiological effect.

The addition of soda ash to the raw water prior to the application of alum was tried first, but the “fixing” of the color rendered its subsequent removal by the latter solution more difficult, so that this method of treatment was abandoned. The addition of the soda ash to the raw water immediately after the application of alum was an improvement, but it was found that the “fixing” of the color still continued, and that in order to obtain an alkalinity of 10 parts the former would run as high as 25 parts.

On account of the high price of soda ash, lime was substituted near the end of February. After numerous laboratory experiments, it was decided to introduce a saturated solution of lime water into the partially decolorized and clarified raw water as it passed from one compartment of the settling basin to the other. After considerable interruption of the operation of the plant, due to the various changes necessitated by this treatment, the lime and alum were so regulated as to give a filtered water, under normal working conditions, of the following characteristics:

*From operating report for week ending July 1, 1916.*

	Color. <sup>1</sup>	Free carbonic acid. <sup>1</sup>	Alkalinity. <sup>1</sup>	Iron. <sup>2</sup>	Soap, hardness. <sup>2</sup>
Raw water.....	65-110	3.0-7.5	19-21	1.45	13.5
Filtered water.....	3-7	2.0-3.5	11-18.5	0.1	26.0

<sup>1</sup> Daily determinations.

<sup>2</sup> Weekly composite of daily samples.

The amount of alum consumed during the above week varied from 330 to 406 pounds and the lime from 115 to 140 pounds per million gallons.

In order to obtain the best results from the treatment of a raw-water supply of this composition, with a fixed plant arrangement, it is necessary to effect the removal and precipitation of a large proportion—the larger the better—of the coloring matter,

and iron prior to the addition of the lime. In order to assist in the accomplishment of this, a temporary wooden baffle was erected in each of the compartments of the basins into which the raw water first discharges. It was noticed that there was a short circuiting of the floc from the inlets to these compartments to the slots in the concrete baffle walls, 35 feet away, and at which points the lime solution was added. This baffle has effected a considerable improvement, but the final size and position to give the best results will be decided upon later. Experiments are also under way in the line of aerating the raw water after the addition of alum, in order to remove some of the free carbonic acid liberated by this coagulant, and consequently effect a considerable reduction in the amount of lime.

With an average daily output of 700,000 gallons of filtered water it had been the practice to operate two or more filters intermittently during the day and night, thus calling for a similar application of alum and lime. As this interfered with the treatment of the water, the delivery of the controllers was so adjusted that the discharge from one filter would practically equalize the pumpage of water into the mains.

Some idea of the action of the filtered water from this plant, when containing from 3.5 to 5.5 parts of free carbonic acid, 11 to 14 parts of alkalinity, 8 to 13 parts of color, and 0.1 to 0.4 parts of iron, on galvanized-iron pipe may be obtained from the following data. This pipe has been in service about 4½ years. Its length is not known at the present time. It carries filtered water to the laboratory and is in constant use during the day, but shut off during the night. The determinations under the heading of "Water standing over night" were made from liter samples collected from the first water drawn in the morning after the water had been shut off from about 5 p. m. to 7.30 a. m. The determinations under the heading of "Water after running 15 minutes" were made on samples collected about 15 minutes later than those listed under the first heading, during which time the water was constantly running with the tap wide open. Its temperature averaged about 28° C.

Date.	Water standing over night.				Water after running 15 minutes.			
	Alka- linity.	Free car- bonic acid.	Color.	Iron.	Alka- linity.	Free car- bonic acid.	Color.	Iron.
1916.								
May 5.....	12.5	7.0	40	1.60	12.5	7.0	12	0.70
May 6.....	11.5	8.0	50	2.05	10.5	8.0	9	.55
May 7.....	14.0	6.5	40	1.80	14.0	6.5	15	.65
May 8.....	15.0	6.5	55	2.15	15.0	4.5	16	.35
May 9.....	12.0	6.5	110	4.10	15.5	4.0	10	.45
May 10.....	16.0	6.0	33	1.30	14.0	4.0	15	.45
May 11.....	14.0	5.0	55	1.70	12.5	5.5	14	.40
May 12.....	18.5	2.5	50	1.70	13.5	4.0	10	.35
May 13.....	14.0	6.0	55	1.65	13.0	4.0	23	.50
May 14.....	15.0	5.5	55	1.05	8.5	6.5	15	.50
May 15.....	13.5	7.0	34	1.15	21.0	5.5	14	.30
May 16.....	12.5	5.5	38	1.00	11.5	5.5	11	.25
May 17.....	11.5	7.0	90	2.65	11.0	5.0	10	.30
May 18.....	11.5	3.5	30	.65	12.0	3.5	11	.20
May 20.....	14.0	5.5	50	1.90	13.0	5.0	20	.50
May 28.....	16.0	4.5	32	1.15	9.0	4.5	14	.55
May 29.....	15.0	5.0	55	1.75	10.0	6.5	9	.30
May 30.....	13.5	5.0	45	1.40	15.0	7.0	6	.15
May 31.....	16.5	6.0	49	1.30	15.0	3.5	9	.25
June 2.....	19.0	5.0	70	2.55	20.5	4.0	15	.55
June 3.....	19.0	2.0	32	1.40	17.5	4.5	14	.90
June 6.....	16.5	4.0	32	1.30	15.5	2.5	6	.40
June 7.....	17.0	4.0	28	1.30	14.5	4.0	5	.20
June 9.....	16.0	3.5	29	.70	13.5	3.5	7	.70
June 10.....	11.5	4.5	33	1.25	10.0	5.5	9	.80
June 12.....	15.5	5.5	45	.35	9.5	5.5	6	.20
June 14.....	15.0	6.0	55	.55	10.0	6.5	9	.25
June 15.....	12.0	5.5	33	.95	9.5	5.5	3	.10

From these data it is seen that comparatively large amounts of iron are taken up by this water while standing in the pipe for 14-hour periods. Undoubtedly all of the galvanizing has been removed from the pipe, for in most of the samples collected after the water had been running for 15 minutes the iron content was larger than in the discharge from the filters. Equally large amounts of iron have been found in samples collected under similar conditions from service pipes of different buildings. Not only is there an iron taste in such water, but it forms rust spots on clothes during washing, stains porcelain fixtures, and affects the taste of coffee, tea, and cocoa.

On June 15, 1916, 42 feet of new galvanized-iron pipe, which had never been used, was connected directly to the pump discharge for experimental purposes. A brass faucet was placed on the other end. From 8 a. m. to 5 p. m. on each day filtered water was running through this pipe at the rate of about 1 gallon per minute. From 5 p. m. to 8 a. m. the water is shut off.

The analyses of the samples collected up to date are given in the following table.

Date.	Water standing over night.				Water after running 1 hour.			
	Alka- linity.	Free car- bonic acid.	Color.	Iron.	Alka- linity.	Free car- bonic acid.	Color.	Iron.
1916.								
June 15.....					11.0	5.5	2	0.65
June 16.....	46.5	3.5	20	0.45	16.0	2.5	9	.10
June 17.....	38.5	7.0	15	.25	11.0	8.0	4	.10
June 18.....	14.5	16.0	10	1.35	12.5	3.0	10	.20
June 19.....	22.5	8.5	10	.70	10.0	5.0	9	.15
June 20.....	19.5	6.5	10	.20	14.5	3.5	6	.10
June 21.....	15.5	3.0	9	1.00	12.5	4.5	8	.20
June 22.....	19.0	6.5	12	.65	14.5	3.5	4	.15
June 23.....	20.0	3.0	15	.30	11.5	5.5	6	.15
June 24.....	26.0	2.0	10	.90	12.5	3.0	8	.20
June 25.....	22.0	3.5	10	.35	16.0	2.0	5	.10
June 26.....	23.5	2.5	12	.15	15.5	4.0	4	.10
June 27.....	21.5	3.0	10	.35	20.0	2.0	7	.20
June 28.....	28.5	1.5	15	.40	19.0	2.0	7	.15
June 29.....	28.5	1.5	15	.35	17.0	2.0	3	.10
June 30.....	28.5	1.5	15	.35				

The noticeable amounts of color and iron in the samples of water collected after standing overnight indicate that even with a larger amount of alkalinity and smaller amount of free carbonic acid the filtered water still has a marked corrosive action on galvanized iron pipe. During the 15 days covered in the above table the dissolved oxygen averaged about 6.7 parts per million, or 85 per cent of saturation.

The action of this water on lead pipe is also under observation, but a sufficient number of lead analyses have not been made to permit a definite conclusion as to whether or not it will be permissible to use it for service pipes in place of galvanized iron pipe.

*Bacteriological data.*—Tables Nos. 12 to 14, inclusive, marked as follows: Table No. 12, Numbers of Colonies of Bacteria in Raw Water; Table No. 13, Numbers of Colonies of Bacteria in Water Delivered to Mains; and Table No. 14, Numbers of Members of the B. Coli Group, contain monthly summaries of the bacteriological examinations of samples of water made throughout the year.

The following table contains the yearly means and medians of the numbers of colonies of bacteria in the raw and filtered water as determined on nutrient and lactose agar incubated at 37.5° C. for 24 hours. They are taken from Tables Nos. 12 and 13.

	Nutrient agar.		Lactose agar.	
	Yearly mean per c. c.	Yearly median per c. c.	Yearly mean per c. c.	Yearly median per c. c.
Raw water.....	421	324	106	90
Water delivered to mains.....	594	400	36	16

As at the Mount Hope purification plant, the numbers of colonies of bacteria in the filtered water have exceeded or equaled those in the raw and settled water samples. This has been due partly to a multiplication of bacteria in the water passing through the sedimentation basins and partly to a multiplication in the filters which started in the latter part of the fiscal year ending June 30, 1914, and has continued ever since.

The elimination of the multiplication of bacteria in the sedimentation basins and the sterilization of the filtered water will be necessary in order to effect a reduction of bacteria in the latter. Notwithstanding the negative "bacterial removal" of both



the Mount Hope and Agua Clara purification plants, no cases of typhoid fever nor any other water-borne disease have been traced to the use of water from these plants.

The monthly averages of numbers of *B. Coli* in the raw water varied from 24.1 to 3,243 per liter with a yearly average of 1,162; in the filtered water delivered to the mains, from 0 to 213 per liter with a yearly average of 45; in the water collected from the distribution system, from 0 to 100 per liter with a yearly average of 42.

*Physical and chemical data.*—This is summarized in Table No. 17, Physical and Chemical Character of Raw and Filtered Water, Agua Clara Purification Plant. The following determinations are made daily: Odor of raw and filtered water, turbidity of raw, settled, and filtered water, color of raw and filtered water, and free carbonic acid of the raw, settled, and filtered water. The entries in the table under these headings are the weekly averages of the daily determinations. The remaining tests, with the exception of nitrites, nitrates, and dissolved oxygen, are made once each week on a composite of daily samples.

The apparent color of the raw water varied from 30 to 110 parts. The color of the filtered water varied from 0 to 24, the latter color due to experiments with lime. The odor of the raw water ranged from 1v to 3 e, and that of the filtered water from 0 to 1 v plus 1 e. The turbidity of the raw water varied from 13 to 45 parts. The free carbonic acid of the raw water varied from 0 to 8 parts. In the filtered water the range was from 1.5 to 6.5 parts. The alkalinity of the raw water varied from 14 to 20 parts, and that of the filtered water from 4 to 16.5 parts. The soap hardness of the raw water ranged from 11.1 to 24.7, and that of the filtered water from 14.3 to 33 parts. The oxygen consumed of the raw water varied from 3.4 to 8.95 parts, and that of the filtered water from 0.2 to 5.35 parts. The chlorine varied from 5 to 7.5 parts. The raw water contained from 0.3 to 2.05 parts of iron, and the filtered water from 0.05 to 0.9 part. In the last five months of the year nitrites and nitrates were absent from the raw and filtered water. The dissolved oxygen in the raw water varied from 3.93 to 8.16 parts, equivalent to 48.6 to 91 per cent of saturation. The dissolved oxygen in the filtered water varied from 5.6 parts to 7.6 parts, equivalent to 70 to 93 per cent of saturation.

*Operative data.*—This is summarized in Table No. 3, Annual Report of Operation of Agua Clara Purification Plant for Fiscal Year Ending June 30, 1916.

The monthly volumes of raw water varied from 20,625,000 to 24,480,000 gallons, with a yearly average of 22,580,000 gallons. The monthly volumes of water delivered to the mains varied from 18,203,000 to 21,605,000 gallons, with a yearly average of 18,191,000 gallons. The monthly volumes of wash water varied from 614,000 to 1,756,000 gallons, with a yearly average of 1,235,000 gallons.

The "gallons per filter hour" varied from 24,300 to 31,500 per month, with a yearly average of 28,110. The "million gallons per acre per day" varied from 88,400,000 to 114,500,000, with a yearly average of 102,200,000. The average filter runs per month varied from 9.2 to 32.9, with a yearly average of 16.2 hours. The maximum filter run per month varied from 16.7 in January, 1916, to 58.8 hours in April, 1916.

The "number of filters washed" varied from 28 in April to 87 in January, 1916, with a yearly average of 54. The "percentage of wash water" varied from 2.96 in March to 7.90 in January, 1916, with a yearly average of 5.82.

The pounds of alum consumed per month varied from 4,908 in July, 1915, to 8,342 in June, 1916, with a yearly average of 6,279, and a total of 75,343 pounds. The pounds per million gallons varied from 221 to 388 for the above months, with a yearly average of 277. During the last four months of the year the pounds of lime consumed averaged 3,108, or 144 pounds per million gallons.

*Superintendence.*—The resident chemists during the year were Messrs. Harry T. Campion and Theodore R. Kendall.

#### MIRAFLORES PURIFICATION PLANT.

This plant, in operation since March 14, 1915, supplies filtered and sterilized water to Paraiso, Pedro Miguel, Corozal, Balboa, Balboa Heights, Ancon, and Fort Grant, in the Canal Zone, and the City of Panama, with a combined population of about 75,000. The source of the raw water is the Chagres River arm of Gatun Lake at Gamboa. This river is approximately 65 miles long, with a drainage basin of 559 square miles. Gatun Lake backs up the river for about 10 miles, so that a mixture of the two waters forms the raw-water supply of the filter plant. The plant comprises the following units: Aeration basin, sedimentation basin, rapid sand filters, clear-water basin, and sterilization chamber.

*Aeration basin.*—This basin, measuring 86 by 130 feet, is equipped with 105 nozzles, which are arranged in 7 batteries of 15 each. The nozzles are so adjusted that, under ordinary operating conditions, the raw water is discharged at an angle of 20 degrees in

a thin sheet, which breaks up into coarse or fine drops, depending upon the height to which the water is thrown, which averages about 15 feet. The following table shows the reduction in free carbonic acid effected by the aeration:

*Free carbonic acid.*

Months.	Raw water.				Aerated water.			
	Median.	Mean.	Maximum.	Minimum.	Median.	Mean.	Maximum.	Minimum.
<b>1915.</b>								
July.....	3.8	3.6	5.5	1.2	1.5	1.6	3.8	1.0
August.....	4.0	4.2	6.5	3.0	1.5	1.65	3.0	1.0
September.....	4.0	4.1	7.0	1.5	1.5	1.63	3.0	.5
October.....	4.5	4.9	8.0	3.5	2.5	2.4	3.5	1.5
November.....	4.0	3.8	7.0	1.5	1.5	1.65	3.5	.5
December.....	3.0	2.9	4.5	1.5	1.5	1.37	2.0	1.0
<b>1916.</b>								
January.....	3.5	3.5	5.0	2.0	1.7	1.7	3.0	1.0
February.....	3.5	3.55	4.5	2.5	1.5	1.65	2.5	.5
March.....	4.0	4.1	5.0	3.0	2.0	2.2	4.0	1.0
April.....	5.0	4.9	6.0	3.0	2.5	2.3	3.5	1.5
May.....	4.5	4.7	7.0	3.5	2.0	2.0	2.5	1.0
June.....	4.0	3.9	6.0	2.5	1.5	1.6	2.5	.5

Based on the difference between the means, the percentage reductions, in the order of the months, run as follows: 55, 61, 61, 45, 57, 54, 52, 54, 47, 53, 57, and 59.

The addition of free carbonic acid due to the use of alum, varying from 119 to 249 pounds per million gallons, increased the final content of the filtered water to 2.7 to 13.5 parts per million, with a general average of about 6 parts.

The following table, prepared from 37 determinations of dissolved oxygen, shows the increase effected by the aeration:

	Parts per million.		Per cent of saturation.	
	Raw.	Aerated.	Raw.	Aerated.
Median.....	4.43	7.50	62.5	92.0
Mean.....	5.23	7.64	64.4	94.3
Maximum.....	7.30	8.03	77.0	78.0
Minimum.....	3.20	6.66	40.7	84.0

The varying intensities of the odors in the raw water have always been reduced by the aeration, so that the filtered water has never been characterized by an odor of an intensity greater than 1, using Whipple's scale as a basis.

The aerated water flows over three weirs into three concrete mixing chambers located in the basement of the head house. Each chamber, 37 feet long, 15 feet wide, and 8 feet deep, is divided transversely into eight compartments by 6-inch walls, which form alternate submerged and overflow weirs. The alum solution is added to the aerated water as it enters the first compartments of the mixing chambers by means of a specially designed orifice box.

*Sedimentation basins.*—After passing through the mixing chambers, the raw water discharges into three cross-connected parallel concrete sedimentation basins. The length of each basin is 300 feet, the combined width of the three is 125 feet, and the depth at the floor valleys is 17.75 feet and that at the summits 16.5 feet. At the present time an average sedimentation period of 11 hours is obtained.

Each basin is divided into three compartments by two pressure baffle walls, which are provided with five rectangular openings, 1.5 feet wide by 6 feet long, placed 3.5 feet below the water level. Extending across these baffle walls in front of the openings there are concrete skimming troughs which reach to within a foot of the normal water level. Between the pressure walls there are two light baffle walls which contain four openings 6 feet wide, extending from within 2.5 feet of the top to 3 feet from the bottom of the basin. All of the valves on the underdrainage system of the basins are hydrau-

lically operated gate valves controlled from an operating table located in the head house.

By means of weirs in the two divisional walls at the inlet end the three basins may be operated as one large basin, water passing from one to the other. Each basin is also equipped with gates at the outlet end, so that any one may be thrown out of service for cleaning.

Only 0.66 per cent of the water treated with alum was wasted in cleaning the basin at this plant, as compared with 5.88 and 6.54 per cent at the Mount Hope and Agua Clara plants. A similar multiplication of bacteria does not interfere with the operation of the plant, as the following table shows:

*Numbers of colonies of bacteria per c. c.*

[Nutrient agar at 37.5° C., 24 hours.]

Month.	Raw water.			Settled water.		
	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.
1915.						
July.....	274	825	19	152	290	17
August.....	197	868	14	133	950	16
September.....	201	1,270	87	96	360	6
October.....	175	250	45	46	131	1
November.....	465	1,450	79	65	190	4
December.....	285	768	80	85	226	10
1916.						
January.....	196	480	22	191	550	4
February.....	147	460	39	108	790	25
March.....	152	282	59	117	206	66
April.....	350	832	130	256	1,050	60
May.....	248	680	108	123	400	50
June.....	405	4,500	92	273	1,788	36

At the filter building end of the sedimentation basin the settled water enters a receiving box from which it passes upon the filters through two 30-inch cast-iron pipes.

*Rapid sand filters.*—There are 14 rapid sand gravity filters, constructed of reinforced concrete, measuring 19.75 by 21.5 feet, and 11 feet deep to the floor, in which the under-drainage system is placed. They are arranged in two rows of 7 units each, with the operating floor and pipe gallery between. Each unit has a sand area of 425 square feet, or 0.00975 of an acre, making a total of 5,950 square feet. If operated at a rate of 125,000, 000 gallons per acre per day each unit will deliver 1,220,000 gallons per 24 hours.

In place of the usual ridge block and pipe systems of underdrainage there is a reinforced concrete false bottom, 12 inches thick, which forms the top of a pressure chamber 2 feet deep. In the false bottom there are placed 1,677 vertical three-eighths inch brass feed pipes, spaced 6 inches center to center. The ends of the pipes projecting above the false bottom are bent 180 degrees, so that the wash water instead of discharging upward is deflected directly upon the floor or gravel. On the ends of these pipes are screwed brass strainers, leaving a space of about  $1\frac{1}{4}$  inches between the latter and the floor, or top of the false bottom. The strainer is a slightly buckled circular plate seven-eighths of an inch in diameter, pierced with twenty-five one-sixteenth inch holes, and swedged into a hexagonal base, ending in a three-eighths inch threaded sleeve for screwing over the three-eighths inch brass feed pipe from the pressure chamber.

In each filter there are 24 inches of Chagres River gravel arranged in three layers, as follows:

Layer.	Thick- ness.	
Bottom.....	8	Passed by $1\frac{1}{4}$ -inch square mesh. Retained on 1-inch square mesh.
Middle.....	12	Passed by 1-inch square mesh. Retained on $\frac{7}{8}$ -inch square mesh.
Top.....	4	Between $\frac{7}{8}$ and $\frac{1}{2}$ inch in diameter.

Thirty inches of Chame Beach sand, with an average effective size and uniformity coefficient of 0.41 and 1.7, respectively, complete the filtering material.

An independent air system is placed between the small and medium grades of gravel. The air wash has been used only a comparatively few times during the year in order to assist in the breaking up of hard spots and removing mud patches.

The pressure chambers were built to withstand a maximum pressure of 28 pounds per square inch. When a filter is washed at a rate of 6,400 gallons per minute, or 15 gallons per square foot of sand surface, equivalent to a 24-inch rise of wash water per minute, a pressure of about 12 pounds per square inch is developed on the false bottom. Under these conditions an excellent distribution of wash water results and the sand bed is raised  $8\frac{1}{2}$  inches above its normal elevation, or to within  $12\frac{1}{2}$  inches of the weirs of the wash-water troughs.

The strainers were not placed on the feed pipes in three of the filters. When washed at the same rate as the filters equipped with strainers a pressure of 6 pounds per square inch is developed on the false bottom. The distribution of wash water is equally as good, and the sand is floated to the same height above its normal level. At the end of the year pressure chambers of filters equipped with and without strainers were examined, and it was found that no sand had worked down through the feed pipes in either case. From the experience gained during the year with filters of this type it is considered that strainers are unnecessary.

In April, 1915, the distance from the tops of the troughs to the sand ranged from 18.6 to 21.85 inches; in June, 1916, the distance ranged from 18.7 to 22.67 inches. The average loss of sand during this period was 0.82 inch, representing a total loss of 2.42 cubic feet for the 14 filters. This sand has been washed over the edges of the troughs. Neither sand nor gravel has been removed from any of the filters during the year, and no repairs of any nature have been made to the filter bottoms.

The wash water is effectively removed by one central and six lateral concrete troughs. Weirs are cut in the troughs so that the maximum travel of suspended particles is limited to 2.5 feet. When washing at the rate mentioned above the depth of water over the weirs is  $1\frac{1}{2}$  inches, and there is sufficient current at the filter wall ends of the lateral troughs to prevent the settling out of suspended particles.

Each filter is operated by hydraulic valves controlled from a slate operating table, each of which, in addition to the usual equipment, is provided with small 10-watt green and red lamps, so connected that the former burns when the filter is in operation, and the latter starts to burn when the loss of head reaches a fixed point.

The discharge of filtered water from each filter is regulated by a controller which consists of a simple round open-top concrete box, approximately 2.5 feet in diameter, and 3.5 feet deep, cast on the floor of the pipe gallery; a circular bronze orifice cast in the floor and opening into the clear-water basin; a copper float 2.25 feet in diameter carrying a stem which will operate a small vertical piston valve, and a 10-inch hydraulic valve placed on the effluent line leading into the controller box. By adjusting this float the discharge from each unit may be varied from 1,120,000 to 1,317,000 gallons per 24 hours, at the respective rates of 115,000,000 to 135,000,000 gallons per acre per day.

The following table summarizes the data relating to the filters:

Number of units.....	14
Sand area per unit.....square feet..	425
Dimensions of unit:	
Length in feet.....	21.5
Width in feet.....	19.75
Depth in feet to false bottom.....	11
Depth in feet to true bottom.....	14
Wash-water troughs:	
Type.....	(1)
Number.....	(2)
Thickness of concrete.....inches..	2.5
Dimensions—	
Main trough.....feet..	21.5 by 2.42
Lateral troughs.....do..	8.66 by 1.66
Per cent of sand area covered by horizontal area of troughs.....	32.8
Average distance above sand.....inches..	21

<sup>1</sup> Reinforced concrete.

<sup>2</sup> One main and 6 laterals.

Washing of filters:		
Type.....	(1)	
Vertical rise of water per minute—		
Figured on area below troughs.....inches..		24
Figured on area at plane of troughs.....do....		35.8
Gallons of water per minute.....		6.400
Gallons of water per square foot of sand surface.....		15
Sand bed lifted above normal.....inches..		8.25
Loss of head through filter—		
Equipped with strainers.....feet..		27.6
Without strainers.....do....		13.8
Maximum travel of suspended particles.....do....		2.5
Depth of water over edges of troughs.....inches..		1.75
Filter bottom:		
Type.....	(2)	
Material.....	(3)	
Thickness.....feet..		1
Feed pipes, brass—		
Diameter, inside.....inches..		0.364
Position.....	(4)	
Spaced, centers.....inches..		6
Total number per filter.....		1,677
Strainers—		
Type.....	(5)	
Position.....	(6)	
Number and size of holes.....	25; $\frac{1}{16}$ -inch	
Relation between area of holes in strainers and the sand surface of one filter.....	<sup>7</sup> 1 to 475	
Relation between area of holes in feed pipes, and the sand surface in one filter.....	<sup>8</sup> 1 to 350	
Filtering material:		
Sand—		
Source.....	(9)	
Depth.....inches..		30
Effective size.....		0.41
Uniformity coefficient.....		1.70
Gravel—		
Bottom layer (thickness, 8 inches).....size in inches..		$1\frac{3}{4}$ to 1
Middle layer (thickness, 12 inches).....do....		1 to $\frac{7}{16}$
Top layer (thickness, 4 inches).....do....		$\frac{1}{16}$ to $\frac{3}{16}$
Operation:		
Loss of head—		
Average initial.....feet..		1
Average final.....do....		11.5
Normal depth of water over sand.....do....		5.25

<sup>1</sup> High velocity water wash, separate air system.

<sup>2</sup> False bottom.

<sup>3</sup> Reinforced concrete.

<sup>4</sup> Vertical, with ends projecting above false bottom bent 180 degrees.

<sup>5</sup> Hexagonal base and circular plate,  $\frac{7}{8}$ -inch in diameter.

<sup>6</sup> Screwed on feed pipes, pointing downward.

<sup>7</sup> Or 0.21 per cent.

<sup>8</sup> Or 0.28 per cent.

<sup>9</sup> Chame Beach.

*Clear-water basin.*—This basin is located under the filter building, and has a capacity of 900,000 gallons.

*Sterilization chamber.*—From the clear-water basin the filtered water flows through a 30-inch cast-iron main and Venturi meter into the sterilization or injection chamber, in which is installed the orifice tanks for controlling the application of hypochlorite of lime. "The injection chamber is, in a general way, a concrete pressure box approximately 24.5 feet by 17 feet by 6 feet, inside depth, divided longitudinally into two main divisions. The water may be allowed to pass through both divisions simultaneously, or through one, while the other is closed down for cleaning or repairs. Each division is divided into compartments having curved and flat-faced concrete baffles placed in them, of such design and arranged in such a manner as may be expected to give the utmost agitation and mixing to the water as it passes through. Upon entering the first compartment of each division the water will pass through two verti-

cal slots about 5.5 feet in length by 6 inches in width, in front of which, splitting the flow, will be placed two perforated bronze solution pipes which will enter the top of the chamber through a regular stuffing box."

As the chamber is under an average pressure of 17 pounds per square inch, it is necessary to pump the solution into the water by duplicate motor driven centrifugal pumps. Twenty days after the plant was placed in operation it was found that the accumulation of calcium carbonate on the interior of one of the pumps and its discharge line was of such thickness as to prevent the delivery of the normal volume of hypochlorite solution. Throughout the year it has been necessary to clean the pumps and discharge lines about every 10 days. The duplicate equipment allowed this to be done without any interruption to the application of the hypochlorite.

On account of this trouble and the high cost of hypochlorite, one of Wallace & Tiernan Co.'s automatic chlorinators was purchased. Its installation was under way at the end of the fiscal year.

The bleach was shipped from the States in 100-pound drums, and stored after its arrival in a dry room. The following table shows the per cent of available chlorine in the bleach after its transit and storage prior to use, as determined by analyses of samples from 30 to 40 drums per month:

Month.	Per cent of available chlorine.		
	Average.	Maximum.	Minimum.
1915.			
July.....	33.0	36.7	28.3
August.....	30.6	37.1	19.0
September.....	29.3	35.6	26.5
October.....	25.3	34.3	.....
November.....	31.8	38.0	27.4
December.....	31.4	39.0	19.7
1916.			
January.....	30.6	37.0	20.7
February.....	32.0	37.6	23.7
March.....	30.9	38.6	24.8
April.....	24.2	28.3	20.4
May.....	25.1	31.7	18.0

*Bacteriological data.*—Tables Nos. 4 to 7, inclusive, marked as follows: Table No. 4, Numbers of Colonies of Bacteria in Raw Water; Table No. 5, Numbers of Colonies of Bacteria in Water Delivered to Mains; Table No. 6, Numbers of Colonies of Bacteria in Samples from Taps on Distribution System, and Table No. 7, Numbers of Members of the B. Coli Group, contain monthly summaries of the bacteriological examinations of samples of water made throughout the year.

The following table contains the yearly means and medians of the numbers of bacteria in the raw and sterilized water as determined on nutrient and lactose agar incubated at 37.5° C. for 24 hours. They are taken from the above-mentioned tables.

Source.	Nutrient agar.		Lactose agar.	
	Yearly mean, per c. c.	Yearly median, per c. c.	Yearly mean, per c. c.	Yearly median, per c. c.
Raw water.....	266	192	96	55
Water delivered to mains.....	1.5	0	1.0	0
Water from taps on distribution system.....	32.9	4	5.8	1

The monthly averages of numbers of B. Coli in the raw water varied from 186 to 2,715 per liter, with a yearly average of 1,225; in the sterilized water distributed to the mains, from 0 to 16.7 per liter, with a yearly average of 4.4, and in 7 out of 12 months B. Coli were not found in 1 and 10 c. c. amounts of water; in the water collected from the distribution system from 0 to 41.9 per liter, with a yearly average of 12. Bacteria of a general group of lactose fermenting anaerobes have been isolated from presumptive tests made on samples of sterilized water collected both at the plant and from the distribution system in Panama and Ancon.

During the latter part of the fiscal year the physiologist and Mr. E. J. Tucker started an exhaustive investigation of the members of the *B. Coli* group in the Canal Zone water supplies. While a sufficient amount of work has not been done to warrant the publication of any final conclusions, a brief report of progress may be made.

In Tables A, B, and D the raw-water samples are from the Chagres River; the filtered water is from the Miraflores purification plant, and is unsterilized; samples from the distribution system, Panama and Ancon, are of sterilized water; water-cooler samples are from a cooler in which the ice and water are in contact, the latter being sterilized water from the Miraflores purification plant; Panama train samples are from the water coolers from the first-class coaches, in which the ice and water are in contact, the latter being sterilized water from the Miraflores purification plant.

TABLE A.

	Source of samples.						
	Miraflores purification plant.			Taps on distribution system, Panama and Ancon.	Ice-cooler samples.	Panama train samples.	Total.
	Raw water.	Settled water.	Filtered water.				
Number of strains (1).....	126	121	38	40	73	30	428
Number of strains positive to dextrose (2) and negative to lactose.....	15	26	7	14	20	5	87
Number of strains positive to dextrose and lactose.....	103	86	27	26	49	22	313
Ratio column 1 to column 2.....	11.9	21.5	18.4	35	27.4	16.7	.....
Reaction of dextrose (pos.) and lactose (neg.) organisms to Clark's medium:							
Low ratio—							
Number.....	0	1	0	15	13	0	.....
Per cent.....	0	3.1	0	35.7	15	0	.....
High ratio—							
Number.....	15	25	7	8	17	5	.....
Per cent.....	100	96.1	100	57.1	85	100	.....
Separation of dextrose (pos.) and lactose (pos.) organisms into species according to standard methods:							
<i>B. Communiior</i> .....	25	22	5	5	9	3	69
<i>B. Communis</i> .....	14	7	3	2	2	1	29
<i>B. Aerogenes</i> .....	42	41	13	19	37	14	166
<i>B. Acidilactici</i> .....	22	17	6	0	1	4	50

17 out of 9 were positive to dextrose and mannite and negative to all other sugars used.

Table A shows the total number of colonies, 428, isolated either from neutral red agar or litmus lactose agar plates after growth in lactose peptone bile, and their division into certain groups. One group contains the organisms which ferment dextrose but not lactose, the other group contains the organisms which ferment both of these sugars. The significance of the former group in the water supplies is in doubt at the present writing. The latter group has been further separated according to the reactions of the organisms with saccharose and dulcitol. It is evident that the varieties arrange themselves in the following order, according to frequency of occurrence, *B. aerogenes*, *B. communiior*, and *B. communis*.

The Clark's medium referred to in this table is that used by Clark and Rogers in their studies. It consists of 0.5 per cent dextrose and 0.5 per cent  $K_2HPO_4$ . The low-ratio organisms are those which give an acid reaction, using methyl red as an indicator, after incubation at 30° C. for five days, and the high-ratio organisms are those which give an alkaline reaction under the same conditions.

Table B shows the characteristics of 87 organisms positive to dextrose and negative to lactose. These organisms produce 10 per cent or less gas in lactose peptone bile at the end of 48 hours incubation; they form weak acid colonies on neutral red agar and Endo medium; nearly all are positive to saccharose and mannite; they reduce nitrates and form indol; and nearly all react alkaline to Clark's medium, thereby falling into the high-ratio group.

One characteristic organism of most frequent occurrence in the Panama tap samples (sterilized water) produced a white colony with a deep red center on neutral red agar; gave a trace of gas in lactose bile; produced gas from dextrose and mannite,

but none from lactose, dulcitol, saccharose, or raffinose; reduced nitrates; failed to produce indol; and reacted acid with Clark's medium, thereby falling into the low-ratio group. Of these organisms this is the only one which did not fall into the high-ratio group.

TABLE B.

	Source of samples.					
	Miraflores purification plant.			Samples from distribution system, Panama and Ancon.	Water-cooler samples.	Panama train samples.
	Raw water.	Settled water.	Filtered water.			
Number positive to dextrose and negative to lactose.....	15	26	7	14	20	5
Per cent positive to dulcitol.....	79.8	34.6	14.3	28.6	5	20
Per cent positive to saccharose.....	100	96.1	42.9	56.1	90	100
Per cent positive to mannite.....	100	97.5	100	100	100	100
Per cent positive to raffinose.....	46.4	53.9	42.9	51.2	80	80
Reduction of nitrates:						
Per cent giving NH <sub>3</sub> .....	93.3	100	100	100	100	100
Per cent giving NO <sub>2</sub> .....	73.2	96.1	100	92.8	85	80
Per cent giving positive indol.....	6.7	38.4	14.3	35.7	20	60
Per cent with low gas ratio.....	0.0	3.9	0.0	35.7	15	0
Per cent with high gas ratio.....	100	96.1	100	57.2	85	100

In Table C the four species are subdivided into varieties, according to reactions with mannite, raffinose, Clark's medium, production of indol, and reduction of nitrates. It is seen that all varieties of *B. acidilactici* and *B. communis* fall into the low-ratio group.

TABLE C.—Classification of *B. coli* group into species and varieties.

Group.	Number.			Mannite.	Raffinose.	Indol.	Nitrate reduction.	Gas ratio.
	Filtered water.	Settled water.	Raw water.					
<i>B. communior</i> .....		3	3	Positive...	Positive...	Positive...	Positive...	High.
Do.....		2	7	do.....	do.....	do.....	do.....	Low.
Do.....	5	11	8	do.....	do.....	Negative...	do.....	High.
Do.....		2	4	do.....	do.....	do.....	do.....	Low.
Do.....			1	do.....	Negative...	Positive...	do.....	Do.
Total.....	5	18	22	45				
<i>B. communis</i> .....		0	1	do.....	Positive...	do.....	do.....	Do.
Do.....		4	2	do.....	do.....	Negative...	do.....	Do.
Do.....	2	1	7	do.....	Negative...	Positive...	do.....	Do.
Do.....	1	2	4	do.....	do.....	Negative...	do.....	Do.
Total.....	3	7	14	24				
<i>B. aerogenes</i> .....	1	2	1	do.....	Positive...	Positive...	do.....	High.
Do.....	6	9	12	do.....	do.....	do.....	do.....	Low.
Do.....	5	16	15	do.....	do.....	Negative...	do.....	High.
Do.....		10	3	do.....	do.....	do.....	do.....	Low.
Do.....			8	do.....	Negative...	Positive...	do.....	Do.
Total.....	12	37	39	88				
<i>B. acidilactici</i> .....		2	3	do.....	Positive...	do.....	do.....	Do.
Do.....	2	3	5	do.....	do.....	Negative...	do.....	Do.
Do.....	1	4	9	do.....	Negative...	Positive...	do.....	Do.
Do.....	2	8	4	do.....	do.....	Negative...	do.....	Do.
Do.....			1	Negative...	do.....	do.....	do.....	Do.
Total.....	5	17	22	44				



Table D is the same as Table C without the separation of the species into varieties.

TABLE D.—*Characteristics of the four species of the B. coli group.*

Per cent of positive results.	Miraflores purification plant.			Samples from distribution system, Panama and Ancon.	Water-cooler samples.	Panama train samples.
	Raw water.	Settled water.	Filtered water.			
<b>B. Communior:</b>						
Mannite.....	100	100	100	100		
Raffinose.....	95.8	100	100	100		
Nitrate reduction—						
NO <sub>2</sub> .....	95	84.9	66.7	40		
NH <sub>3</sub> .....	95.8	100	80	100		
Indol.....	41.7	25	0	80		
Gas ratio—						
High.....	56	70	100	20		
Low.....	44	30	0	80		
<b>B. Communis:</b>						
Mannite.....	100	100	100			
Raffinose.....	21.4	57.2	0			
Nitrate reduction—						
NO <sub>2</sub> .....	50	100	66.7			
NH <sub>3</sub> .....	92.6	100	100			
Indol.....	57.1	14.2	66.7			
Gas ratio—						
High.....	0	0	0			
Low.....	100	100	100			
<b>B. Aerogenes:</b>						
Mannite.....	100	95.1	92.2	89.3	100	94.5
Raffinose.....	73.8	92.7	92.2	89.3	78.6	91.9
Nitrate reduction—						
NO <sub>2</sub> .....	52.4	75.6	84.6	68.4	71.0	94.2
NH <sub>3</sub> .....	100	97.6	100	94.6	100	100
Indol.....	52.5	29.2	60.6	31.6	21.4	18.9
Gas ratio—						
High.....	43.9	49.8	46.1	63.1	42.9	91.9
Low.....	56.1	51.2	53.9	36.9	57.1	5.4
<b>B. Acidi-lactici:</b>						
Mannite.....	95.3	100	83.3			
Raffinose.....	36.4	29.4	33.3			
Nitrate reduction—						
NO <sub>2</sub> .....	75	70.5	33.3			
NH <sub>3</sub> .....	100	100	100			
Indol.....	54.6	35.3	33.3			
Gas ratio—						
High.....	0	0	0			
Low.....	100	100	100			

Table E is a classification of the strains of the B. coli group isolated from feces of some of the animals which are found in large numbers on the watersheds of the reservoirs. The 27 strains positive to dextrose and lactose may be arranged as follows:

Number.	Species.
17	B. Communior.
6	B. Communis.
2	B. Aerogenes.
2	B. Acidi-lactici.

Of 37 strains isolated from samples of water collected from Comacho and Rio Grande reservoirs, both uninhabited and policed, thereby practically excluding the possibility of contamination with human feces, 25 were classed as B. aerogenes and 12 as B. Communior. Therefore it appears, from the small amount of data at hand, that there are other sources of B. aerogenes than the animals to account for the predominance of the species.

TABLE E.—Varieties of the *B. coli* group isolated from animal feces.

Animal.	Dextrose.	Lactose.	Saccharose.	Dulcife.	Mannite.	Raffinose.	Nitrate reduction.		Indol.		Clark's medium.
							NO <sub>2</sub>	NH <sub>3</sub>	A.	B.	
TAPIR.	1. Positive...	Positive...	Positive...	Trace...	Positive...	Positive...	Positive...	Positive...	Positive...	Positive...	Red.
	2. do.....	do.....	do.....	Positive...	do.....	do.....	do.....	do.....	do.....	do.....	Do.
	3. do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Negative...	Negative...	Do.
	4. do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Yellow.
	5. do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Positive...	Positive...	Red.
	6. do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.
	7. do.....	Negative...	do.....	do.....	Negative...	Negative...	do.....	do.....	do.....	do.....	Do.
MULE.	8. Positive...	Positive...	Negative...	Negative...	Positive...	Negative...	Positive...	Positive...	Positive...	Positive...	Red.
	9. do.....	do.....	do.....	Positive...	do.....	Positive...	do.....	do.....	do.....	do.....	Do.
	10. do.....	do.....	Positive...	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.
RABBIT.	11. Positive...	Negative...	Positive...	Negative...	Positive...	Positive...	Positive...	Positive...	Positive...	Negative...	Yellow.
WATER DOG.	12. Positive...	Positive...	Positive...	Negative...	Positive...	Positive...	Positive...	Positive...	Positive...	Positive...	Red.
	13. do.....	do.....	do.....	Positive...	do.....	do.....	do.....	do.....	do.....	do.....	Do.
	14. do.....	do.....	do.....	Negative...	do.....	do.....	do.....	do.....	Negative...	do.....	Do.
	15. do.....	do.....	Negative...	Positive...	do.....	Negative...	do.....	do.....	Positive...	do.....	Do.
	16. do.....	Negative...	Positive...	Negative...	Negative...	do.....	do.....	do.....	Negative...	do.....	Do.
	17. Positive...	Negative...	Positive...	Negative...	Negative...	Negative...	Positive...	Positive...	Negative...	Negative...	Red.
	18. do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.
IGUANA.	19. do.....	Positive...	do.....	Positive...	Positive...	Positive...	do.....	do.....	Positive...	Positive...	Yellow.
	20. do.....	do.....	Negative...	do.....	do.....	Negative...	Negative...	do.....	do.....	do.....	Red.
	21. do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.
	22. do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.
	23. do.....	do.....	do.....	do.....	do.....	do.....	Positive...	do.....	do.....	do.....	Do.
	24. do.....	do.....	do.....	do.....	do.....	do.....	Negative...	do.....	do.....	do.....	Do.
	25. do.....	do.....	Positive...	do.....	do.....	Positive...	Positive...	do.....	do.....	do.....	Yellow.
DEER.	26. Positive...	Positive...	Positive...	Positive...	Positive...	Positive...	Positive...	Positive...	Positive...	Positive...	Red.
	27. do.....	do.....	do.....	do.....	do.....	do.....	Negative...	do.....	do.....	do.....	Do.
	28. do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.
	29. Positive...	Positive...	Positive...	Positive...	Positive...	Positive...	Negative...	Positive...	Negative...	Negative...	Red.
AGOUTI.	30. do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.
	31. do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.
	32. do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	do.....	Do.

NOTE.—Indol A, Ehrlich's test. Indol B, procedure in standard methods of water analysis.

*Physical and chemical data.*—This is summarized in Table No. 15, Physical and Chemical Character of Raw and Filtered Water, Miraflores Purification Plant. The following determinations were made daily: Odor of raw and filtered water, turbidity of raw and filtered water, color of raw and filtered water, and free carbonic acid of the raw, aerated, and filtered water. The following determinations were made on composites of daily samples: Alkalinity, soap hardness, oxygen consumed, chlorine and iron. Determinations of nitrites, nitrates, free ammonia and albuminoid ammonia are made on samples collected on some day during each week. Total solids were determined on weekly composites of daily samples until near the end of the year, when they were determined on monthly composites of daily samples.

The odor of the raw water varied from 1 e to 4 e, or 1 v to 3 v, and that of the filtered water from 0 to 1 v. The turbidity of the raw water varied from 1 to 102, all of which was removed. The color of the raw water ranged from 10 to 153, and that of the filtered water from 0 to 10. The alkalinity of the raw water varied from 39.4 to 60.5, and that of the filtered water from 29 to 51.7 parts. The soap hardness of the raw water varied from 29.9 to 57 parts, and that of the filtered water from 29.6 to 49.1 parts. The oxygen consumed of the raw water varied from 0.40 to 3.20, and that of the filtered water from a trace to 2.2 parts. The free ammonia in the raw and filtered water varied from 0 to 0.046. The albuminoid ammonia in the raw water varied from 0 to 0.098, and that in the filtered water from 0 to 0.060 parts. The nitrites in the raw water varied from 0 to 0.003, and in the filtered water from 0 to 0.035 parts. The nitrates in the raw water varied from 0 to 0.12, and in the filtered water from 0 to 0.10 parts. The chlorine in the raw water varied from 4.8 to 10.3 parts. The iron in the raw water varied from 0 to 3.4, and in the filtered water from 0 to 0.08 parts. The total solids in the raw water varied from 95 to 182, and in the filtered water from 93 to 136 parts.

*Operative data.*—This is summarized in Table No. 1, Annual Report of Operation of Miraflores Purification Plant for Fiscal Year Ending June 30, 1916.

The monthly volumes of raw water varied from 226,376,000 to 272,178,000 gallons, with a yearly average of 248,963,000 gallons. The monthly volumes of water delivered to the mains varied from 217,997,000 to 256,297,000 gallons, with a yearly average of 243,081,000 gallons. The monthly volumes of wash water varied from 2,992,000 to 6,891,000 gallons, with an average of 5,126,000 gallons.

The "gallons per filter hour" varied from 51,400 to 54,000, with a yearly average of 53,000. The "million gallons per acre per day" varied from 126,200,000 to 132,900,000, with a yearly average of 130,300,000. The average filter runs per month varied from 21.7 to 50.6 hours, with a yearly average of 31.3 hours. The maximum filter run per month varied from 39.7 in February, 1916, to 95.9 hours in November, 1915. The minimum filter run per month varied from 2.0 hours in July, 1915, to 31.5 in May, 1916.

The "number of filters washed" varied from 86 in November, 1915, to 185 in February, 1916, with a yearly average of 149. The "per cent of wash water" varied from 1.26 in November, 1915, to 2.67 in March, 1916, with a yearly average of 2.07.

The pounds of alum consumed per month varied from 30,755 in March, 1916, to 59,240 in November, 1915, with a yearly average of 43,502, and a total of 522,024 pounds. The pounds per million gallons varied from 119 to 249 for the above months, with a yearly average of 175.

The pounds of hypochlorite consumed per month varied from 3,589 to 4,975, with a yearly average of 4,428 pounds. Figuring on a basis of 35 per cent available chlorine, the pounds applied per million gallons varied from 13.2 to 19.5, with a yearly average of 16.1. The parts per million of available chlorine varied from 0.55 to 0.82, with a yearly average of 0.68.

*Superintendence.*—The resident superintendent of this plant was Mr. E. J. Tucker, also chief assistant to the physiologist. Mr. H. F. Schmidt has served as chemist, and Mr. H. W. Nightingale as biologist.

#### RESERVOIRS.

The reservoirs have been inspected once or more each month in order to see that the shore lines were kept in proper condition and to obtain information along general lines. The following table gives some data in regard to the four now in use:

Name.	Supplies water to—	Elevation.	Volume of water.	Area of watershed.	Area of water surface.
Brazos Brook....	Mount Hope purification plant.....	49.5	650,000,000	Acres, 896.7	156
Agua Clara.....	Agua Clara purification plant.....	68.0	612,000,000	1,019.5	69.5
Rio Grande.....	West side of canal.....	235.0	400,000,000	2,015.5	62
Comacho.....	do.....	365.0	280,000,000	592.0	34.3

NOTE.—File 47-A-123-part 1.

All of the watersheds are uninhabited and policed to guard against trespassing, so that the only sources of pollution are the numerous animals, such as the tapir, monkey, deer, cat, conaho, squirrel, wild hog, tiger cat, porcupine, sloth, ant eater, honey bear, mongoose, agouti, rabbit, raccoon, opossum, manigourda, otter, saiona, etc. Alligators, iguanas, and lizards are also prevalent. Without going into this matter in detail it is sufficient to state that the sum total of the pollution introduced directly and indirectly into the waters of the reservoirs is of considerable magnitude.

The one animal which probably adds the largest amount of fecal matter to the water is the tapir, which deposits its excreta directly into the water. During the dry season it hunts out the small streams or feeders which, while nearly dry, have small pools of water into which the animal, weighing from 700 to 1,000 pounds, continues to defecate from time to time, until a pool is filled up, after which it moves to another. The droppings resemble those of the horse. At the end of the dry season there is a large amount of tapir manure in the beds of all the creeks or feeders, which is carried into the reservoirs by the first hard rain of the wet season.

Practically all of the acid formers, developing on litmus lactose agar, in raw water samples from the reservoirs, appear at the start of the rainy season. The strains of the *B. coli* group, isolated from 7 animals, show that organisms, similar to those occurring in human feces, are added to the water.

During the latter part of the fiscal year a start was made on clearing off the trees on those portions of the watershed nearest to the reservoir and the feeders. This is regarded as a matter of considerable importance because the leaves falling from the trees and lying on the ground and in the beds of the feeders are the principal source of the coloring matter in the water, and it is also expected that the wild animals will be driven back and off the watersheds into other tracts of timbered land.

Physical and chemical analyses of samples of water from Comacho and Rio Grande reservoirs may be found in Tables Nos. 18 and 19; mineral analyses in Table No. 20. Brazos Brook and Agua Clara are covered by Tables Nos. 16 and 17 in the columns headed "Raw."

#### PLANKTON STUDIES.

During the year 358 microscopical examinations of samples of water from various sources were made at the three laboratories. The following table gives an idea of the sizes of the various organisms observed:

*Ranges in the sizes of various microscopic organisms examined at Agua Clara Laboratory, Feb. 3 to July 1, 1916.*

[Theodore R. Kendall, Biologist.]

Organism.	Group.	Range of dimensions of organisms.			
		Standard units.	Dimensions in microns.		
			Diameter.	Length.	Width.
Actinophrys.....	Prot.....	1	25-30		
Anabaena.....	Cyan.....	1-5	5		5
Anguillula.....	Verm.....	2		120	10
Anuraca.....	Roti.....	5-35		60-150	40-80
Aphanizomenon.....	Cyan.....	1			10
Aphanacapsa.....	Cyan.....	1-2		30-40	20-30
Asplanchna.....	Roti.....	10-35		100	60
Brachionus.....	Roti.....	45		80	50
Ceratum.....	Prot.....	2-4		30-50	40-50
Chlamydomonas.....	Prot.....	1-4	20-50		
Chroococcus.....	Cyan.....	1-2	20-40		
Closterium.....	Chlor.....	1-2		80-120	10
Coleps.....	Prot.....	2-4		30-50	10-15
Conferva.....	Chlor.....	2-8	10		10
Cosmarium.....	Chlor.....	4-2	10-40	10-30	
Cyclops.....	Crust.....	20-75		120-200	50-70
Cyclotella.....	Diat.....	2-3	30-40		
Cymbella.....	Diat.....	1-3		20-40	20
Dactylosphaerium.....	Prot.....	1-2	25-50		
Diatoma.....	Diat.....	2-3		40-60	20
Dinobryon.....	Prot.....	1		30-40	15-20
Euglena.....	Prot.....	1-2		20-40	15-25
Euglypha.....	Prot.....	4		80	30
Epithemia.....	Diat.....	1-2		20-40	15-35

*Ranges in the sizes of various microscopic organisms examined at Agua Clara Laboratory, Feb. 3 to July 1, 1916—Continued.*

Organism.	Group.	Range of dimensions of organisms.			
		Standard units.	Dimensions in microns.		
			Diameter.	Length.	Width.
Glenodinium.....	Prot.....	1-4	25-50		
Gloeocapsa.....	Cyan.....	1-2	25-40		
Gloeocystis.....	Chlor.....	2-4	40-80		
Halteria.....	Prot.....	3		40	30
Hyalotheca.....	Chlor.....	2-10			30
Leptothrix.....	Schiz.....	2-5		40-100	10
Lynghya.....	Cyan.....	4-8		30-80	10-30
Mastigocerca.....	Roti.....	10		70	40
Melosira.....	Diat.....	2-8			15
Monas.....	Prot.....	$\frac{1}{2}$ -1	15		
Nais.....	Verm.....	60		400-500	45-50
Navicula.....	Diat.....	4		40-60	15-25
Nitzschia.....	Diat.....	1		80	10
Notholca.....	Roti.....	5-20		80-120	50-80
Penium.....	Chlor.....	3		60	20
Peridinium.....	Prot.....	2-4		40-60	25-45
Phacus.....	Prot.....	9		65	50
Protococcus.....	Chlor.....	$\frac{1}{2}$ -1	10-25		
Raphidium.....	Chlor.....	3-4		60-80	20
Raphydomonas.....	Prot.....	2-3		30	20
Rivularia.....	Cyan.....	3-4		60-80	20
Rotifer.....	Roti.....	20		200	40
Sphaerosozoma.....	Chlor.....	4-10		80-100	20-30
Spirogyra.....	Chlor.....	20-100			40
Staurostrum.....	Chlor.....	1-8		20-80	20-80
Surirella.....	Diat.....	1-2		25-40	20
Synura.....	Prot.....	1	25		
Tetraspora.....	Chlor.....	1-2	20-40		
Trachelomonas.....	Prot.....	1-2	25		
Ulothrix.....	Chlor.....	2-5		20	10-30
Verticella.....	Prot.....	1		40-80	10-15
Water Mite.....	Crust.....	25-40		35	15
				120-160	120-160

This tabulation covers samples from Agua Clara Reservoir, Brazos Brook Reservoir, Comacho Reservoir, and the following sets of samples from Lake Gatun: Monte Lirio, Frijoles, Darien, and spillway and center wall of Gatun Dam and Locks at Gatun.

A study of the Plankton data shows that, contrary to studies of other tropical waters, the diatoms in the reservoirs, lakes, and rivers on the Isthmus of Panama are relatively abundant.

Chambers in an article in the twenty-third annual report of the Missouri Botanical Gardens, "The relation of algae to dissolved oxygen and carbon-dioxide," states that "Fritsch thinks that the scarcity of diatoms in tropical waters, noted especially at Ceylon, is due to the small amount of dissolved gases in the waters, and not to the high temperature, per se, except in so far as it influences the amount of dissolved gases. He found them only in aerated waters, i. e., running streams. He did not have data as to the amount of dissolved gases, but assumes a priori that a high temperature, 25° C., must of necessity indicate a low gas content, as indicated by figures from Forel's tables. The lowest temperature attained by the lowland waters of Ceylon was 25° C., which in the table corresponds to 5 c. c. of oxygen per liter."

"In this connection it is interesting to mention H. W. Clark's report of *Melosira* in Guatemala, where, he says, 'One of the most striking features of the Amatitlan plankton is the abundance of *Melosira*, which is found abundantly in the bottom of nearly all the hauls, and usually makes up the main mass of all the filamentous material. The specimens occur in long rigid filaments.'

"West says: 'Diatoms are not a feature of the plankton in the Yan Yean Reservoir at Victoria, Australia, although *Melosira granulata* occurs abundantly, and is never absent from the collections.'"

The following table shows the relative abundance of diatoms in relation to the total number of standard units of Diatomaceae, Chlorophyceae, Cyanophyceae, Protozoa, Fungi and Schizomycetes, Rotifera and Crustacea which were found in the 353 samples of water collected from the Chagres River, Brazos Brook, Agua Clara, Comacho, and Rio Grande Reservoirs and Gatun Lake.

	Total standard units of all classes, per c. c.	Standard units of diatoms, per c. c.	Per cent of diatoms.
Chagres River.....	17,419	11,967	68
Reservoirs:			
Brazos Brook.....	6,778	247	3.6
Agua Clara.....	7,136	108	1.5
Comacho—			
Surface.....	79,107	48,390	61
Subsurface.....	121,634	94,182	77
Rio Grande.....	15,293	5,548	36
Gatun Lake:			
At Frijoles <sup>1</sup> .....	10,588	7,938	75
At Monte Lirio <sup>2</sup> .....	3,330	897	27

<sup>1</sup> One sample per month during 11 months.<sup>2</sup> One sample per month during 12 months.

The small numbers of diatoms in Brazos Brook and Agua Clara Reservoirs offer a striking contrast to those in the other sources of supply. While sufficient data are not available to permit a conclusive explanation, the chemical characteristics in the following table would indicate that the differences in composition of the waters of the various supplies are partly responsible for the variations in the numbers of diatoms. The silica, alkalinity, calcium, magnesium, and total mineral matter are present in noticeably smaller amounts in Brazos Brook and Agua Clara Reservoirs. Nitrates were not determined in the water from the former during the year, and only during the last five months in the water from the latter. During this period no nitrates were found while they were present in varying amounts in the other supplies. As determinations of free ammonia were not made except in the case of Chagres River, its influence is undetermined.

	Source of water.							
	Reservoirs.						Gatun Lake.	
	Chagres River.	Brazos Brook.	Agua Clara.	Comacho.		Rio Grande.	Monte Lirio.	Frijoles.
				Surface.	Sub-surface.			
Temperature.....	26-29.5	27-30.4	27-30.6	26.5-30	26.7-30.5			
Degrees C.....	1 27.7	1 28.5	1 28.5	1 28	1 28.5			
Color.....	10-81	22-32	25-90	10-30	11-170	10-240	5-20	5-18
Turbidity.....	2 1-102	1-24	13-45	1-7	1-20	1-30	0-7	0-10
Alkalinity.....	39-60	22-44	14-20	52-65	43-71	29-63	46-53	44-52
Oxygen:								
P. P. M.....	3.2-7.2	1.75-9.03	3.9-8.0	3.9-11.2	0-6.3			
Per cent Sat.....	40-77	22-116	48-106	49-144	0-83			
Nitrogen as nitrates.....	0-0.1		0-Tr.	0-0.025	0-0.05	0-0.05		
Free NH <sub>3</sub> .....	0-0.046							
Alb. NH <sub>3</sub> .....	0-0.098							
Silica-SiO <sub>2</sub> .....	24.5	11.8	14.9		28.3	24.8		
Soluble.....		72	56.5		104	117		
Solids.....	109							
Calcium-Ca.....	12.6	7.58	3.84		11.76	11.15		
Magnesium-Mg.....	4.1	2.6	1.53		5.68	5.86		
Sulphate radicle (SO <sub>4</sub> ).....	2.86	2.53	2.49		Tr.	0.52		
Iron.....	0-3.4	0.2-1.0	0.3-2.05	0-0.45	0.1-1.6	0.1-3.3	0.10-0.30	0-0.50

<sup>1</sup> Average.<sup>2</sup> Average 6 and 23.

## NOTES.

Chagres River: Figures for SiO<sub>2</sub>, solids, Ca, Mg, and SO<sub>4</sub> represent averages of two mineral analyses of composite samples collected daily during July, 1915, and March, 1916.

Brazos Brook and Agua Clara: The same determinations as listed above were taken from mineral analyses of composite samples collected daily during November from the former and latter reservoirs, respectively.

Comacho: The same determinations as listed above were taken from a mineral analysis of a sample collected on March 31, 1916.

Rio Grande: The same determinations as listed above were taken from a mineral analysis of a sample collected on April 6, 1916.

Of the 20 genera of the class of Diatomaceæ which were identified, *Nitzschia* was predominant, as the following table shows.

Source.	Total standard units of all Diatoms per c. c.	Standard units of <i>Nitzschia</i> per c. c.	Per cent of <i>Nitzschia</i> .
Chagres River.....	11,967	10,653	89
Reservoirs:			
Brazos Brook.....	247	166	67
Agua Clara.....	108	18	16
Comacho—			
Surface.....	48,390	48,171	99
Subsurface.....	94,182	93,350	99
Rio Grande.....	5,548	5,513	99
Gatun Lake:			
At Frijoles.....	7,938	7,884	99
At Monte Lirio.....	897	849	94

The other 19 genera were present in relatively small amounts.

Genera.	Number of standard units per c. c.	Genera.	Number of standard units per c. c.
<i>Synedra</i> .....	754	<i>Cyclotella</i> .....	30
<i>Navicula</i> .....	512	<i>Cocconeis</i> .....	24
<i>Diatoma</i> .....	415	<i>Melosira</i> .....	21
<i>Rhizosolenia</i> .....	193	<i>Stauroneis</i> .....	20
<i>Encyonema</i> .....	152	<i>Meridian</i> .....	8
<i>Amphora</i> .....	121	<i>Fragilaria</i> .....	8
<i>Cymbella</i> .....	73	<i>Epithemia</i> .....	7
<i>Pleurosigma</i> .....	48	<i>Surirella</i> .....	5
<i>Tabellaria</i> .....	47	<i>Asterionella</i> .....	2
<i>Stephanodiscus</i> .....	42	Unidentified.....	7

The seasonal distribution of this class is shown in the following table.

*Seasonal distribution of Diatomaceæ.*

	Source of water.				
	Chagres River.	Reservoirs.			
		Brazos Brook.	Agua Clara.	Rio Grande.	Comacho.
March to July, inclusive:					
Range, standard units.....	26-1, 272	0-102	0-7	16-852	0-18, 480
Average, standard units.....	309	12	2	227	3,000
Number of samples.....	27	19	13	15	31
Number of samples in which class was absent.....	0	6	6	0	13
August to February, inclusive:					
Range, standard units.....	2-8-374	0-168	0-14	3-3-520	4-0-536
Average, standard units.....	72	10	3	69	38
Number of samples.....	50	25	28	27	24
Number of samples in which class was absent.....	0	10	12	0	9

<sup>1</sup> Three samples in March, 1916, did not contain any Diatoms.

<sup>2</sup> Sample collected on Feb. 26, 1916.

<sup>3</sup> Sample collected on Feb. 24, 1916.

<sup>4</sup> Sample collected on Oct. 19, 1915.

Brazos Brook: Two samples in September, 1915, contained 102 and 168 Diatoms, respectively. Omitting these the range for the period of August to February would be 0-16. With the exception of these two counts the distribution was practically the same throughout the year.

Agua Clara: The distribution was practically the same throughout the year.

*Chlorophyceæ*.—The following table shows the relative abundance of this class in relation to the total number of standard units of Diatomaceæ, Chlorophyceæ, Cyanophyceæ, Protozoa, Fungi and Schizomycetes, Rotifera and Crustacea, which were found in the 335 samples of water collected from the Chagres River, Brazos Brook, Agua Clara, Comacho, and Rio Grande reservoirs.

Source.	Total standard units of all classes per c. c.	Standard units of Chlorophyceæ per c. c.	Per cent of Chlorophyceæ.
Chagres River.....	17,419	1,441	8
Reservoirs:			
Brazos Brook.....	6,778	1,150	17
Agua Clara.....	7,136	2,295	32
Comacho—			
Surface.....	79,107	2,814	3.5
Subsurface.....	121,634	3,482	2.8
Rio Grande.....	15,293	2,967	19

Of the 29 genera identified, *Protococcus* and *Staurostrum* were present in the five water supplies with the greatest relative abundance, as the following tabulation shows.

Source.	Standard units of Chlorophyceæ, per c. c.	<i>Protococcus</i> standard units per c. c.	Per cent.	<i>Staurostrum</i> standard units per c. c.	Per cent.
Chagres River.....	1,441	284	19	161	11
Reservoirs:					
Brazos Brook.....	1,150	151	13	477	41
Agua Clara.....	2,295	1,302	56	170	7
Comacho—					
Surface.....	2,814	504	17	346	12
Subsurface.....	3,482	551	15	633	18
Rio Grande.....	2,967	248	8	336	11
Total.....	14,149	3,040	21	2,123	15

The other seven genera were present in the five water supplies, as shown in the following tabulation:

Genera.	Number of standard units per c. c.	Genera.	Number of standard units per c. c.
<i>Cosmarium</i> <sup>1</sup> .....	2,481	<i>Tetraspora</i> .....	68
<i>Pediastrum</i> .....	744	<i>Conium</i> .....	68
<i>Scenedesmus</i> .....	577	<i>Sphaerosoma</i> .....	50
<i>Eudorina</i> .....	549	<i>Xanthidium</i> .....	33
<i>Gloeocystis</i> .....	504	<i>Desmidium</i> .....	26
<i>Ulothrix</i> .....	490	<i>Micrasterias</i> .....	20
<i>Botryococcus</i> .....	417	<i>Ophiocytium</i> .....	18
<i>Arthrodesmus</i> .....	416	<i>Sorastrum</i> .....	17
<i>Pandorina</i> .....	394	<i>Staurogenia</i> .....	12
<i>Closterium</i> .....	228	<i>Penium</i> .....	10
<i>Conferva</i> .....	186	<i>Palmella</i> .....	8
<i>Polypedrium</i> .....	156	<i>Spirogyra</i> .....	3
<i>Coelastrum</i> .....	153	<i>Tetmemorus</i> .....	3
<i>Raphidium</i> .....	77	Unidentified.....	1,221

<sup>1</sup>1,541 s. u. of this genera occurred in samples collected during May and June from Rio Grande Reservoir.



Filamentous desmids do not appear to be so abundant in the Canal Zone reservoirs and the Chagres River as in some other tropical waters, such as those of Ceylon, India, and Yan Yean, Australia, in which Fritsch found a great variety and abundance of forms. The theory had been advanced that filamentous desmids are more abundant in tropical waters because the dissolved oxygen content is low. From the microscopical analyses made during the year the following data relating to this point have been selected.

In 248 samples from the Chagres River, Brazos Brook, Agua Clara, Comacho, and Rio Grande reservoirs, in which chlorophyceæ were found to be present, filamentous forms, *Ulothrix*, *Conferva*, *Spharozoma*, and *Spirogyra*, and desmidium were observed in 56. Out of a total of 14,249 standard units of chlorophyceæ there were only 803 standard units, or 5.8 per cent of these forms.

Out of 55 samples collected from Comacho Reservoir at various depths below the surface, in which dissolved oxygen was entirely lacking in 9 samples and in 17 other samples varied from 2.5 to 83 per cent saturation with an average of 59 per cent, only 3 samples contained filamentous forms, *Ulothrix* and *Spharozoma*, with a total of 40 standard units out of a grand total of 3,482. The temperature of these samples ranged from 26.5 to 30.0° C., with an average of 28° C. Filamentous desmids were not observed in any of the 34 samples collected from the surface of the same reservoir. The dissolved oxygen in these samples varied from 49.5 to 144 per cent saturation, with an average of 93 per cent. The temperature varied from 26.7° C. to 30.5° C., with an average of 28.5° C. The alkalinity in both the surface and subsurface samples varied from 43 to 71 parts per million, expressed as  $\text{CaCO}_3$ .

Out of 42 samples from Rio Grande Reservoir, collected at varying depths below the surface and containing small amounts of dissolved oxygen, filamentous forms were found in 6, amounting to 118 standard units out of a total of 2,967. The alkalinities of these samples varied from 29 to 63 parts per million.

Out of 77 samples from the Chagres River filamentous desmids were observed in 17, amounting to 325 standard units out of a total of 1,441. The dissolved oxygen in these samples varied from 40 to 77 per cent saturation, with an average of 64.4 per cent. The temperature varied from 26 to 29.5° C., with an average of 27.7° C. The alkalinities varied from 39 to 60 parts.

Out of 41 samples from Agua Clara Reservoir filamentous desmids were observed in 19, amounting to 142 standard units out of a total of 2,295. The dissolved oxygen content of the water drawn from this reservoir during the year varied from 48 to 106 per cent saturation, with an average of 80 per cent. The temperature varied from 27 to 30° C., with an average of 28.5° C. The alkalinities varied from 14 to 20.5 parts per million, with an average of 18 parts.

Out of 44 samples from Brazos Brook Reservoir filamentous desmids were observed in 16, amounting to 176 standard units out of a total of 1,150 standard units of chlorophyceæ. The dissolved oxygen content of the water drawn from this reservoir during the year varied from 22 to 119 per cent saturation, with an average of 83 per cent. The temperature varied from 27 to 30.4° C., with an average of 38.5° C. The alkalinities varied from 22 to 44 parts per million, with an average of 35 parts. Out of 176 standard units 166 were found in 10 samples collected between March 22 and May 26, during which time the bottom intake was open and water was drawn from a depth of about 25 feet below the surface. Some of the chemical characteristics of the water during this period are shown in the following table.

	Minimum.	Maximum.
Dissolved oxygen, per cent saturation.....	32	75
Temperature.....	27.3	29.7
Alkalinity.....	38	44
Color.....	22	32
Turbidity.....	7	12
Free carbonic acid.....	1.2	4.2
Iron.....	.25	.60

The smaller number of filamentous forms in the samples collected below the surface from Comacho Reservoir would indicate that the alkalinity and iron are factors to be considered, for while the water in this reservoir was more stagnant and contained less oxygen than that in Brazos Brook Reservoir the alkalinity of the former ranged from 43 to 71 parts as against 38 to 44 parts in the latter and the iron in the former ranged from 0.1 to 4.6 parts, with an average of 1.25 parts, as against 0.25 to 0.60, with an average of 0.5 parts, in the latter.

Abundant growths of *Spirogyra* have been observed on the walls and bottom of the uncovered sedimentation basin of the Miraflores purification plant, which is 125 feet wide by 300 feet long, with an average depth of 16 feet of water under ordinary working conditions, and holds approximately 4,500,000 gallons of water. It is operated on the continuous plan and, theoretically, the water is changed every 12 hours. The greatest growth occurs on the bottom, although long strands may be seen attached to the baffles and walls and iron ladders. The *Spirogyra* also grows on the bottoms of the skimming platforms at the filter building end of the basin, where the water is about 1 foot deep. In general, the water is not sufficiently clear to see the bottom of the basin. The water is fully aerated before it enters the basin, and the dissolved oxygen ranges, in general, between 90 and 100 per cent saturation at the outlet end, so that neither this factor nor poor circulation can account for the luxurious growth. Occasionally the water is so clear that the bottom of the basin may be seen, and at such times a pattern in the sediment of interesting channels, extending from baffle to baffle, presents a striking and unusual appearance. It is thought that these channels are caused by the decay and drawing apart of the *Spirogyra*, but the exact nature of the process is not thoroughly understood at present. Similar growths have never been observed in the basins at the Mount Hope and Agua Clara purification plants.

*Seasonal distribution of chlorophyceæ.*

	Source of water.				
	Chagres River.	Reservoirs.			
		Brazos Brook.	Agua Clara.	Rio Grande.	Comacho.
March to July, inclusive:					
Range, standard units.....	0-190	18-92	10-530	6-644	0-535
Average, standard units.....	24	42	133	141	89
Number of samples.....	27	19	13	15	29
Number of samples in which class was absent.....	6	0	0	0	2
August to February, inclusive:					
Range, standard units.....	0-236	0-67	0-80	2-124	0-140
Average, standard units.....	20	16	17	19	29
Number of samples.....	50	25	28	27	26
Number of samples in which class was absent.....	17	10	2	0	4

*Cyanophyceæ.*—The following table shows the relative abundance of this class in relation to the total number of standard units of Diatomaceæ, Chlorophyceæ, Cyanophyceæ, Protozoa, Fungi and Schizomycetes, Rotifera and Crustacea which were found in the 335 samples of water collected from the Chagres River, Brazos Brook, Agua Clara, Comacho, and Rio Grande reservoirs:

Source.	Total standard units of all classes, per c. c.	Standard units of cyanophyceæ, per c. c.	Per cent of cyanophyceæ.
Chagres River.....	17,419	288	1.6
Reservoirs:			
Brazos Brook.....	6,778	1,082	15.0
Agua Clara.....	7,136	1,001	14.0
Comacho—			
Surface.....	79,107	2,332	3.0
Subsurface.....	121,634	1,627	1.3
Rio Grande.....	15,293	738	4.8

Of the 13 genera identified there was no one form predominant in all of the supplies. The distribution in the five water supplies may be seen in Table No. 23, Distribution of Cyanophyceæ. The following tabulation shows the total standard units of the genera in all samples in which they occurred:

Genera.	Number of standard units per c. c.	Genera.	Number of standard units per c. c.
Aphanocapsa.....	1,895	Lyngbya.....	1,410
Chroococcus.....	1,213	Anabaena.....	1,009
Oscillaria.....	577	Gloeocapsa.....	113
Aphanizomenon.....	87	Rivularia.....	41
Clathrocystis.....	40	Cylindrospermum.....	14
Microcystis.....	13	Sphaerocyga.....	8
Nostoc.....	2	Unidentified.....	646

*Seasonal distribution of Cyanophyceæ.*

	Source of water.				
	Chagres River.	Reservoirs.			
		Brazos Brook.	Agua Clara.	Rio Grande.	Comacho.
<b>March to July, inclusive:</b>					
Range, standard units.....	0-42	0-180	0-60	0-200	0-330
Average, standard units.....	5	33	15	34	40
Number of samples.....	27	19	13	16	31
Number of samples in which class was absent.....	16	1	4	4	10
<b>August to February, inclusive:</b>					
Range, standard units.....	0-16	0-75	<sup>1</sup> 0-292	0-28	<sup>2</sup> 0-132
Average, standard units.....	3	13	30	7	15
Number of samples.....	50	25	28	26	24
Number of samples in which class was absent.....	25	3	5	7	11

<sup>1</sup> Sample collected on Oct. 14, 1915.

<sup>2</sup> Sample collected on Oct. 19, 1915.

*Protozoa.*—The following table shows the relative abundance of this class in relation to the total number of standard units of Diatomaceæ, Chlorophyceæ, Cyanophyceæ, Protozoa, Fungi and Schizomycetes, Rotifera and Crustacea which were found in the 335 samples of water collected from Chagres River, Brazos Brook, Agua Clara, Comacho, and Rio Grande reservoirs:

Source.	Total standard units of all classes per c. c.	Standard units of Protozoa per c. c.	Per cent of Protozoa.
Chagres River.....	17,419	2,091	12
Reservoirs:			
Brazos Brook.....	6,778	2,558	37
Agua Clara.....	7,136	2,243	31
Comacho—			
Surface.....	79,107	22,245	28
Subsurface.....	121,634	14,572	12
Rio Grande.....	15,293	3,067	20

Of the 27 genera identified, Glenodinium and Chlamydomonas were present in the five water supplies with the greatest relative abundance, as the following tabulation shows:

Source.	Standard units of Protozoa per c. c.	Glenodinium standard units per c. c.	Per cent.	Chlamydomonas standard units per c. c.	Per cent.
Chagres River.....	2,091	485	23	474	22
Reservoirs:					
Brazos Brook.....	2,558	1,859	72	149	5.8
Agua Clara.....	2,243	1,533	68	22	0.9
Comacho—					
Surface.....	22,245	490	2.2	13,852	62.0
Subsurface.....	14,572	722	4.9	6,824	46.0
Rio Grande.....	3,067	146	4.7	2,268	74.0
	46,776	5,235	11	23,589	50.0

The other 25 genera were present in the 5 water supplies, as shown in the following tabulation:

Genera.	Number of standard units per C. C.	Genera.	Number of standard units per C. C.
Peridinium.....	3,177	Diffugia.....	31
Phacus.....	1,275	Coleps.....	30
Monas.....	532	Amoeba.....	22
Trachelomonas.....	291	Synura.....	20
Euglena.....	263	Colpidium.....	18
Dinobryon.....	235	Mallomonas.....	16
Nassula.....	136	Epistylis.....	8
Vorticella.....	77	Euplotes.....	8
Raphidomonas.....	71	Euglypha.....	7
Zoothamnium.....	52	Codonella.....	4
Cryptomonas.....	46	Arcella.....	4
Dactylosphaerium.....	42	Unidentified.....	4,237
Halteria.....	40	Do.....	6,353
Enchelys.....	38	(Acorn shape).....	.....

*Seasonal distribution of Protozoa.*

	Chagres River.	Brazos Brook.	Agua Clara.	Rio Grande.	Comacho.
March to July, inclusive:					
Range, standard units.....	0-512	0-188	28-216	8-284	16-3,850
Average standard units.....	50	33	92	92	314
Number of samples.....	27	19	13	16	31
Number of samples in which class was absent.....	3	3	0	0	0
August to February, inclusive:					
Range, standard units.....	0-90	0-204	4-112	2-244	3-784
Average standard units.....	14	77	37	60	201
Number of samples.....	50	25	28	26	24
Number of samples in which class was absent.....	5	4	0	0	0

The following tables accompany the physiologist's section of this report:

Table No. 1. Summary of Operation of Miraflores Purification Plant for Fiscal Year Ending June 30, 1916.

Table No. 2. Summary of Operation of Mount Hope Purification Plant for Fiscal Year Ending June 30, 1916.

Table No. 3. Summary of Operation of Agua Clara Purification Plant for Fiscal Year Ending June 30, 1916.

Table No. 4. Numbers of Colonies Per Cubic Centimeter in Raw Water, Miraflores Purification Plant, for Fiscal Year Ending June 30, 1916.

Table No. 5. Number of Colonies Per Cubic Centimeter in Water Delivered to Mains, Miraflores Purification Plant, for Fiscal Year Ending June 30, 1916.

Table No. 6. Number of Colonies per Cubic Centimeter in Water from Distribution System Supplied by Miraflores Purification Plant, for Fiscal Year Ending June 30, 1916.

Table No. 7. Numbers of the Members of the Colon Group in the Inflow and Outflow at Miraflores Purification Plant, for Fiscal Year Ending June 30, 1916.

Table No. 8. Numbers of Colonies per Cubic Centimeter in Raw Water, Mount Hope Purification Plant, for the Fiscal Year Ending June 30, 1916.

Table No. 9. Numbers of Colonies per Cubic Centimeter in Water Delivered to Mains, Mount Hope Purification Plant, for the Fiscal Year Ending June 30, 1916.

Table No. 10. Numbers of Colonies per Cubic Centimeter in Water from Distribution System Supplied by Mount Hope Purification Plant, for Fiscal Year Ending June 30, 1916.

Table No. 11. Numbers of Members of the Colon Group in the Inflow and Outflow at Mount Hope Purification Plant, for Fiscal Year Ending June 30, 1916.

Table No. 12. Numbers of Colonies per Cubic Centimeter in Raw Water, Agua Clara Purification Plant, for Fiscal Year Ending June 30, 1916.

Table No. 13. Numbers of Colonies per Cubic Centimeter in Water Delivered to Mains, Agua Clara Purification Plant, for the Fiscal Year Ending June 30, 1916.

Table No. 14. Numbers of the Members of the Colon Group in the Inflow and Outflow at Agua Clara Purification Plant, for the Fiscal Year Ending June 30, 1916.

Table No. 15. Physical and Chemical Character of Raw and Filtered Water, Miraflores Purification Plant, for the Fiscal Year Ending June 30, 1916.

Table No. 16. Physical and Chemical Character of Raw and Filtered Water, Mount Hope Purification Plant, for the Fiscal Year Ending June 30, 1916.

Table No. 17. Physical and Chemical Character of Raw and Filtered Water, Agua Clara Purification Plant, for Fiscal Year Ending June 30, 1916.

Table No. 18. Physical and Chemical Character of Water from Comacho Reservoir, for Fiscal Year Ending June 30, 1916.

Table No. 19. Physical and Chemical Character of Water, Rio Grande Reservoir, for Fiscal Year Ending June 30, 1916.

Table No. 20. Mineral Analyses.

Table No. 21. Diatomaceae, Genera Present in Samples Examined During Fiscal Year Ending June 30, 1916.

Table No. 22. Chlorophyceae, Genera Present in Samples Examined During Fiscal Year Ending June 30, 1916.

Table No. 23. Cyanophyceae, Genera Present in Samples Examined During Fiscal Year Ending June 30, 1916.

Table No. 24. Protozoa, Genera Present in Samples Examined During Fiscal Year Ending June 30, 1916.

Table No. 25. Fungi and Schizomycetes; Rotifera; Crustacea; Genera Present in Samples Examined During Fiscal Year Ending June 30, 1916.

TABLE NO. 1.—Summary of operation of Miraflores purification plant.

Month.	Volumes of water.			
	Raw.	Filtered.	Delivered to consumers.	Wash water.
1915.				
July.....	226,376,000	222,661,000	217,997,000	4,664,000
August.....	227,064,000	229,734,000	225,364,000	4,370,000
September.....	233,147,000	230,843,000	225,055,000	5,788,000
October.....	264,140,000	259,363,000	254,531,000	4,732,000
November.....	238,330,000	237,361,000	234,369,000	2,992,000
December.....	260,966,000	260,118,000	255,527,000	4,591,000
1916.				
January.....	272,178,000	265,176,000	259,543,000	5,633,000
February.....	240,384,000	244,460,000	238,561,000	5,885,000
March.....	257,387,000	261,302,000	254,411,000	6,891,000
April.....	242,873,000	247,366,000	242,139,000	5,227,000
May.....	265,936,000	261,436,000	256,297,000	5,139,000
June.....	258,780,000	258,780,000	253,185,000	5,595,000
Total.....	2,987,561,000	2,978,486,000	2,916,979,000	61,507,000
Average.....	248,963,000	248,207,000	243,081,000	5,126,000

Month.	Operation of filters.								
	Total filter hours.	Average hours per filter per day.	Gallons of water per filter hour.	Million gallons per acre per day.	Filter runs in hours.			Number of filters washed.	Per cent of wash water.
					Average.	Maxi-mum.	Mini-mum.		
1915.									
July.....	4,121.5	9.5	54,000	132.9	29.3	60.1	2.0	143	2.02
August.....	4,325.1	9.9	52,500	129.0	28.7	54.4	10.5	149	1.91
September.....	4,400.0	10.5	52,400	128.9	21.7	46.9	10.3	198	2.51
October.....	5,031.0	11.6	51,400	126.2	35.8	53.6	13.0	141	1.87
November.....	4,447.1	10.6	53,400	131.1	50.6	95.9	29.7	86	1.26
December.....	4,969.8	11.5	52,500	129.0	40.9	78.7	23.1	124	1.76
1916.									
January.....	4,970.8	11.7	53,300	131.0	30.2	49.5	17.3	166	2.13
February.....	4,594.2	11.3	53,100	130.5	24.2	39.7	12.2	185	2.41
March.....	4,818.0	11.3	53,100	130.5	27.3	41.2	14.6	180	2.67
April.....	4,651.3	11.1	53,100	130.5	31.5	44.3	17.7	145	2.13
May.....	4,928.2	11.4	53,000	130.2	34.8	57.0	31.5	142	1.97
June.....	4,849.5	11.6	53,400	131.1	38.3	57.7	18.4	128	2.16
Total.....	56,206.5							1,787	
Average.....	4,683.9	11.0	53,000	130.3	31.3	95.9	2.0	149	2.07

Month.	Sedimentation basis.		Chemicals applied.					
	Million gallons of alum-treated water wasted.	Per cent of alum-treated water wasted.	Alum.		Hypochlorite of lime.			
			Total pounds.	Pounds per million gallons.	Total pounds.	Pounds per million gallons.	Pounds per million gallons 35 per cent bleach.	Parts per million available chlorine.
1915.								
July.....	4,500,000	1.9	53,842	238	4,565	20.5	17.5	0.73
August.....	302,000	.13	41,124	182	4,938	21.5	19.0	0.80
September.....			36,330	156	4,736	20.5	19.5	0.82
October.....	4,500,000	1.7	47,121	178	5,456	21.0	19.2	0.83
November.....			59,240	249	4,279	18.0	18.1	0.76
December.....			46,762	180	3,979	15.2	16.0	0.67
1916.								
January.....	4,827,000	1.7	44,988	165	3,589	13.5	13.2	0.55
February.....			31,144	130	3,797	15.6	14.8	0.62
March.....	1,000,000	.38	30,755	119	3,972	15.3	13.2	0.55
April.....			35,036	143	4,301	17.4	13.6	0.57
May.....	4,832,000	1.8	43,570	164	4,975	19.0	14.0	0.59
June.....			52,112	202	4,556	17.5	15.4	0.65
Total.....	19,961,000		522,024		53,143			
Average.....		0.66	43,502	175	4,428	17.8	16.1	0.63

TABLE NO. 2.—Summary of operation of Mount Hope purification plant.

Month.	Volumes of water.			
	Raw.	Filtered.	Delivered to mains.	Wash water.
1915.				
July.....	148,894,000	145,994,000	141,270,000	4,724,000
August.....	146,988,000	144,438,000	138,750,000	5,688,000
September.....	145,158,000	142,258,000	134,080,000	8,178,000
October.....	131,756,000	127,806,000	116,480,000	11,326,000
November.....	120,426,000	116,826,000	110,210,000	6,616,000
December.....	124,846,000	116,796,000	109,100,000	7,696,000
1916.				
January.....	130,715,000	126,715,000	116,220,000	10,495,000
February.....	122,971,000	116,171,000	106,650,000	9,521,000
March.....	131,559,000	125,359,000	117,160,000	8,199,000
April.....	121,203,000	116,353,000	110,980,000	5,373,000
May.....	129,201,000	123,151,000	117,460,000	5,691,000
June.....	121,068,000	115,368,000	109,660,000	5,708,000
Total.....	1,574,785,000	1,517,235,000	1,428,020,000	89,215,000
Average.....	131,232,000	126,436,000	119,002,000	7,435,000

Month.	Operation of filters.								
	Total filter hours.	Average hours per filter per day.	Gallons per filter hour.	Million gallons per acre per day.	Filter runs in hours.			Number of filters washed.	Per cent of wash water.
					Average.	Maxi- mum.	Mini- mum.		
1915.									
July.....	2,576.8	13.9	56,600	115.3	24.4	33.7	16.8	107	3.24
August.....	2,493.7	13.4	57,900	118.0	23.0	33.1	16.9	109	3.94
September.....	2,466.8	13.7	57,600	117.4	16.1	25.8	7.7	162	5.76
October.....	2,537.2	14.0	50,300	102.5	15.8	60.8	5.8	230	8.87
November.....	2,298.3	12.7	50,800	103.5	29.3	60.7	8.3	105	5.64
December.....	2,341.0	12.6	49,800	101.5	21.4	48.8	7.3	137	6.58
1916.									
January.....	2,456.9	13.2	51,100	104.1	12.9	21.7	7.0	195	8.28
February.....	2,289.5	13.2	50,700	103.3	12.3	17.3	7.5	190	8.10
March.....	2,450.7	13.2	51,150	104.2	15.5	27.1	9.3	168	6.54
April.....	2,317.3	13.2	50,210	102.3	19.9	31.9	13.3	118	4.60
May.....	2,456.1	13.2	50,140	103.0	19.0	26.0	13.9	132	4.45
June.....	2,319.7	12.9	49,730	101.3	18.2	26.2	11.0	130	4.95
Total.....	29,004.0							1,783	
Average.....	2,417.0	13.27	52,169	106.2	18.9	60.8	16.9	148	5.88

Month.	Sedimentation basins.		Chemicals applied.				
	Million gallons of alum-treated water wasted.	Per cent of alum-treated water wasted.	Alum.		Liquid chlorine.		
			Total pounds.	Pounds per million gallons.	Total pounds.	Pounds per million gallons.	Parts per million available chlorine.
1915.							
July.....	2,900,000	1.95	18,205	122			
August.....	2,550,000	1.74	16,520	113			
September.....	2,900,000	2.00	15,343	106			
October.....	3,950,000	3.00	25,786	196			
November.....	3,600,000	2.99	20,361	169			
December.....	8,050,000	6.46	28,273	226			
1916.							
January.....	4,000,000	3.06	39,630	303			
February.....	6,800,000	5.54	42,553	347	51.25	1.77	0.211
March.....	6,200,000	4.71	41,956	319	117.75	1.01	.120
April.....	4,850,000	4.00	22,957	190	107.75	.97	.115
May.....	6,050,000	4.68	22,701	176	135.50	1.15	.137
June.....	5,700,000	4.71	21,286	176	166.75	1.35	.160
Total.....	57,550,000		315,571		569.00		
Average.....	4,796,000	3.65	26,298	200			

TABLE NO. 3.—*Summary of operation of Agua Clara purification plant.*

Month.	Volumes of water.			
	Raw.	Filtered.	Delivered to mains.	Wash water.
1915.				
July.....	22,152,000	20,927,000	19,414,000	1,513,000
August.....	21,977,000	20,927,000	19,507,000	1,420,000
September.....	22,514,000	21,114,000	19,822,000	1,292,000
October.....	23,702,000	22,127,000	20,578,000	1,549,000
November.....	21,863,000	20,463,000	19,377,000	1,086,000
December.....	24,480,000	23,168,000	21,605,000	1,563,000
1916.				
January.....	23,643,000	22,068,000	20,312,000	1,756,000
February.....	22,267,000	20,867,000	19,958,000	929,000
March.....	22,451,000	20,786,000	20,172,000	614,000
April.....	23,780,000	21,763,000	21,082,000	681,000
May.....	20,625,000	19,225,000	18,256,000	969,000
June.....	21,491,000	19,650,000	18,203,000	1,447,000
Total.....	270,965,000	253,085,000	238,286,000	14,819,000
Average.....	22,580,000	21,090,000	18,191,000	1,235,000

Month.	Operation of filters.								
	Total filter hours.	Average hours per filter per day.	Gallons per filter hour.	Million gallons per acre per day.	Filter runs in hours.			Number of filters washed.	Per cent of wash water.
					Average.	Maxi- mum.	Mini- mum.		
1915.									
July.....	839.9	6.8	24,950	90.7	13.60	29.83	7.00	64	7.20
August.....	715.2	5.8	29,300	106.5	13.70	22.30	7.90	54	6.79
September.....	670.3	5.6	31,500	114.5	14.00	22.30	7.10	52	6.12
October.....	712.7	7.9	31,100	113.0	11.30	19.90	1.70	64	7.00
November.....	714.4	5.9	28,700	104.1	14.90	27.00	4.80	52	5.30
December.....	801.6	6.4	28,900	105.0	12.10	29.60	3.60	81	6.70
1916.									
January.....	791.4	6.3	27,900	101.5	9.20	16.70	3.70	87	7.90
February.....	773.2	6.7	27,000	98.2	15.94	28.10	6.20	45	4.33
March.....	735.39	5.93	28,200	102.5	24.97	52.08	11.33	29	2.96
April.....	892.88	7.44	24,400	88.8	32.89	58.83	9.25	28	3.13
May.....	791.20	6.38	24,300	88.4	18.95	54.58	5.92	41	5.03
June.....	632.51	5.27	31,100	113.1	12.70	30.00	5.58	52	7.36
Total.....	9,070.70							649	
Average.....	755.70	6.37	28,110	102.2	16.19	58.83	1.7	54	5.82

Month.	Sedimentation basins.		Chemicals applied.			
			Alum.		Lime.	
	Million gallons of alum-treated water wasted.	Per cent of alum-treated water wasted.	Total pounds.	Pounds per million gallons.	Total pounds.	Pounds per million gallons.
1915.						
July.....	1,225,000	5.54	4,908	221	.....	.....
August.....	1,050,000	4.80	5,144	234	.....	.....
September.....	1,400,000	6.23	5,992	266	.....	.....
October.....	1,400,000	5.92	5,456	250	.....	.....
November.....	1,400,000	6.42	5,456	249	.....	.....
December.....	1,312,000	5.36	5,714	233	.....	.....
1916.						
January.....	1,575,000	6.66	6,100	258	.....	.....
February.....	1,400,000	6.28	6,030	271	791	.....
March.....	1,665,000	7.43	6,506	290	4,161	185
April.....	2,017,000	8.46	7,392	311	3,249	137
May.....	1,400,000	6.81	7,503	353	2,601	130
June.....	1,841,000	8.58	8,342	388	2,421	123
Total.....	17,685,000	.....	75,343	.....	13,223	.....
Average.....	1,474,000	6.51	6,279	277	1,3108	144

<sup>1</sup> Average of 4 months.



TABLE No. 4.—Numbers of colonies per cubic centimeter in raw water, Miraflores purification plant.

Month.	On gelatine at 20° C., 48 hours.							On nutrient agar at 37.5° C., 24 hours.						
	Number of test days.	Mean per c.c.	Median per c.c.	Variations in numbers: Number of test days.				Number of test days.	Mean per c.c.	Median per c.c.	Variations in numbers: Number of test days.			
				0 to 100.	100 to 300.	301 to 1,000.	Above 1,000.				0 to 100.	101 to 300.	301 to 1,000.	Above 1,000.
1915.														
July.....	15	270	230	2	7	5	1	30	274	225	5	18	7	0
August.....	17	540	327	0	8	7	2	31	197	180	3	25	3	0
September.....	27	187	140	4	20	3	0	30	261	191	1	24	4	1
October.....	28	675	310	0	13	8	7	30	174	97	16	14	0	0
November.....	27	377	390	3	4	7	1	30	465	312	2	12	13	3
December.....	15	377	390	3	4	7	1	30	285	212	1	18	11	0
1916.														
January.....	27	207	163	3	19	5	0	30	196	154	9	15	5	1
February.....	25	212	140	6	16	2	1	29	147	130	12	16	1	0
March.....	18	220	176	3	12	3	0	18	187	137	1	15	2	0
April.....								30	350	308	0	13	17	0
May.....								31	248	206	0	22	9	0
June.....								30	405	243	1	20	8	1
Total.....	172			21	99	40	12	349			51	212	80	6
Average.....		366	197						266	192				
Per cent.....				12.2	57.5	23.3	7.0				14.7	60.7	22.9	1.7

Month.	On litmus lactose agar at 37.5° C., 24 hours.							On litmus lactose agar at 37.5° C., 24 hours—acid formers.								
	Number of test days.	Mean per c.c.	Median per c.c.	Variations in numbers: Number of test days.				Number of test days.	Mean per c.c.	Median per c.c.	Variations in numbers: Number of test days.					
				0 to 50.	51 to 100.	101 to 300.	1,000 to 5,000.				0.	1 to 2.	3 to 5.	6 to 10.	Above 10.	
1915.																
July.....	31	61	55	14	14	3	0	31	.....	.....	14	8	7	20	0	0
August.....	31	14	11	30	1	0	0	30	.....	.....	19	11	0	0	0	0
September.....	29	10	8	29	0	0	0	29	.....	.....	17	4	7	1	0	0
October.....	31	39	37	25	6	0	0	31	.....	.....	9	4	12	5	1	1
November.....	30	163	76	9	7	8	6	30	3.7	2	8	8	5	8	1	1
December.....	30	112	66	12	6	10	2	30	1.4	0	20	6	1	2	1	1
1916.																
January.....	28	98	49	16	5	5	2	28	.4	0	23	4	1	0	0	0
February.....	29	141	115	1	11	16	1	29	.....	.....	27	2	0	0	0	0
March.....	30	78	68	11	10	9	0	31	.....	.....	29	2	0	0	0	0
April.....	30	205	77	7	13	9	1	30	.....	.....	27	3	0	0	0	0
May.....	31	56	45	18	10	3	0	31	.....	.....	27	4	0	0	0	0
June.....	29	179	140	3	3	21	2	29	.....	.....	27	2	0	0	0	0
Total.....	359			175	86	84	14	359			247	58	33	18	3	3
Average.....		96	55						.4	0						
Per cent.....				48.7	24.0	23.4	3.9				68.8	16.2	9.2	5.0	0.8	

TABLE NO. 5.—*Number of colonies per cubic centimeter in water delivered to mains, Miraflores purification plant.*

Month.	On gelatin at 20° C., 48-72 hours.								On nutrient agar at 37.5° C., 24 hours.								
	Number of test days.	Mean per c. c.	Median per c. c.	Number of tests.	Variations in numbers: Number of tests.				Number of test days.	Mean per c. c.	Median per c. c.	Number of tests.	Variations in numbers: Number of tests.				
					0	1 to 10	11 to 25	Above 25.					0.	1 to 5.	6 to 10.	Above 10.	
1915.																	
July.....	15	2.7	0	28	16	11	0	1	31	2.0	0	61	35	22	1	3	0
August <sup>1</sup> .....	23	13.2	1	45	20	17	2	6	30	0.7	0	62	41	20	1	4	0
September <sup>1</sup> .....	30	7.3	1	59	27	25	4	3	31	1.7	0	60	37	18	1	4	0
October.....	30	7.3	1	59	27	25	4	3	31	1.6	0	62	35	21	5	1	3
November.....	25	8.5	1	48	15	28	2	3	30	1.9	0	60	32	23	2	3	1
December.....	14	5.7	1	28	10	14	2	2	30	1.5	0	60	36	21	2	3	1
1916.																	
January.....	24	7.2	2	45	12	22	8	3	29	1.3	0	57	35	18	4	0	0
February.....	27	3.8	1	53	19	33	0	1	29	1.1	0	58	36	18	4	0	0
March.....	23	0.9	0	46	29	16	1	0	31	1.0	0	62	49	11	1	1	0
April.....									30	0.4	0	60	46	14	0	0	0
May.....									31	2.6	1	62	24	31	5	2	2
June.....									30	2.0	0	60	33	22	3	2	2
Total.....	143			352	148	166	19	19	363			724	439	239	29	17	
Average.....		8.2	1		42	47	5.5	5.5		1.5	0		60.7	33.0	4.0	2.3	
Per cent.....																	

Month.	On litmus lactose agar at 37.5° C., 24 hours.								On litmus lactose agar at 37.5° C., 24 hours—acid formers.				
	Number of test days.	Mean per c. c.	Median per c. c.	Number of tests.	Variations in numbers: Number of tests.				Number of test days.	Number of tests.	Variations in numbers: Number of tests.		
					0.	1 to 5.	6 to 10.	Above 10.			0.	1 to 2.	Above 2.
1915.													
July.....	31	0.6	0	62	44	17	1	0	31	62	62	0	0
August <sup>1</sup> .....	31	.4	0	61	47	14	0	0	31	61	60	1	0
September <sup>1</sup> .....	30	.3	0	58	47	11	0	0	30	58	58	0	0
October.....	31	1.5	0	62	39	22	0	1	31	62	59	3	0
November.....	30	1.1	0	59	33	24	0	2	30	59	55	4	0
December.....	30	1.0	1	59	27	28	4	0	30	59	57	2	0
1916.													
January.....	29	1.2	0	57	30	26	1	0	29	57	57	0	0
February.....	29	2.3	1	58	21	31	6	0	29	58	58	0	0
March.....	31	.9	1	62	28	33	1	0	31	62	62	0	0
April.....	30	.7	0	60	32	28	0	0	30	60	59	1	0
May.....	31	1.2	1	62	28	32	2	0	31	62	61	1	0
June.....	29	1.3	1	58	25	31	0	2	29	58	58	0	0
Total.....	362			718	401	297	15	5	362	718	706	12	0
Average.....		1.0	0		55.8	41.4	2.1	0.7			98.4	1.6	0
Per cent.....													0

<sup>1</sup> 48-hour counts not included in annual average.

TABLE NO. 6.—*Number of colonies per cubic centimeter in water from distribution system supplied by Miraflores purification plant.*

Month.	On gelatin at 20° C., 72 hours.								On nutrient agar at 37.5° C., 24 hours.								
	Number of test days.	Mean per c. c.	Median per c. c.	Number of tests.	Variations in numbers: Number of tests.				Number of test days.	Mean per c. c.	Median per c. c.	Number of tests.	Variations in numbers: Number of tests.				
					0.	1 to 10.	11 to 50.	51 to 200.					201 to 1,000.	0.	1 to 50.	50 to 200.	Above 200.
1915.																	
July.....					7	12	9	5	0	26	145	10	77	9	49	6	13
August.....	11	48	5	33	18	24	12	2	0	25	21	3	75	24	42	6	3
September <sup>1</sup> .....	19	10.7	2	56	17	27	7	2	0	25	14	9	75	13	57	5	0
October.....	27	4.1	1	77	29	40	8	0	0	27	75	1	79	36	42	1	0
November.....	18	6.6	1	53	17	27	7	2	0	24	3.4	1	68	30	38	0	0
December.....	13	9.5	2	37	8	23	5	1	0	28	14.6	1	84	32	46	5	1
1916.																	
January.....	22	71	7.5	64	14	21	14	11	4	30	74.0	4.5	88	27	40	15	6
February.....	26	9.3	3	73	26	33	12	2	0	29	5.6	0	87	44	41	2	0
March.....	22	6.0	2	65	16	39	9	1	0	17	9.1	4	51	12	37	2	0
April.....										30	20.3	8	90	15	69	4	2
May.....										31	27.3	18	93	0	78	13	2
June.....										30	52.9	19.5	90	12	52	20	6
Total.....	158			458	135	219	76	24	4	322			957	254	591	79	33
Average.....		20.4	3								32.9	4					
Per cent.....					29.5	47.8	16.6	5.2	0.9					26.6	61.7	8.3	3.4

Month.	On litmus lactose agar at 37.5° C., 24 hours.								On litmus lactose agar at 37.5° C., 24 hours—acid formers.			
	Number of test days.	Mean per c. c.	Median per c. c.	Number of tests.	Variations in numbers: Number of tests.				Number of test days.	Number of tests.	Variations in numbers: Number of tests.	
					0.	1 to 10.	11 to 25.	Above 25.			0.	1 to 2.
1915.												
July.....	26	2.0	0	78	42	34	1	1	26	78	77	1
August.....	26	0.9	0	75	53	21	1	0	26	75	75	0
September <sup>1</sup> .....	24	0.9	0	72	47	25	0	0	24	72	71	1
October.....	27	1.4	0	81	49	31	0	1	27	81	75	6
November.....	24	0.9	0	71	39	32	0	0	24	71	69	2
December.....	28	2.1	0	80	48	29	1	2	28	80	80	0
1916.												
January.....	29	20.0	1	86	33	37	8	8	30	86	86	0
February.....	29	6.1	1	87	24	48	8	7	29	87	87	0
March.....	31	4.4	2	92	33	51	4	4	31	93	93	0
April.....	30	8.6	2	90	24	51	12	3	30	90	90	0
May.....	31	17.1	5	93	10	58	18	7	31	93	93	0
June.....	29	22.6	4	85	25	30	8	22	29	85	84	1
Total.....	334			990	427	447	61	55	335	991	980	11
Average.....		5.8	1									
Per cent.....					43.1	45.1	6.2	5.6			98.9	1.1

<sup>1</sup> On 7 test days the gelatin counts were made at end of 48 hours.



TABLE NO. 8.—Numbers of colonies per cubic centimeter in raw water, Mount Hope purification plant.

Month.	On nutrient agar at 37.5° C., 24 hours.								
	Number of test days.	Mean per c. c.	Median per c. c.	Variations in numbers: Number of test days.					
				0 to 100.	101 to 300.	301 to 500.	501 to 700.	701 to 1,000.	Above 1,000.
1915.									
July.....	31	371	364	0	7	20	4	0	0
August.....	30	397	382	0	17	10	1	2	0
September.....	28	415	400	0	8	11	9	0	0
October.....	29	19,372	1,900	0	3	10	0	0	16
November.....	30	465	362	1	8	13	4	1	3
December.....	31	406	350	0	9	16	5	1	0
1916.									
January.....	31	382	325	0	11	15	5	0	0
February.....	29	644	650	1	0	3	16	9	0
March.....	31	549	570	0	0	11	17	3	0
April.....	29	404	380	0	3	20	6	0	0
May.....	29	379	340	0	10	13	4	2	0
June.....	29	301	250	0	19	8	3	0	0
Total.....	357			2	95	150	73	18	19
Average.....		1,173	380						
Per cent.....				0.6	26.6	42.0	20.4	5.2	5.2

Month.	On litmus lactose agar at 37.5° C., 24 hours.								
	Number of test days.	Mean per c. c.	Median per c. c.	Variations in numbers: Number of test days.					
				0 to 25.	26 to 50.	51 to 75.	76 to 150.	151 to 300.	Above 300.
1915.									
July.....	25	77	79	3	1	7	14	0	0
August.....	25	64	36	8	8	4	3	1	1
September.....	21	111	108	0	2	5	10	4	0
October.....	28	112	87	4	3	4	12	7	0
November.....	24	50	33	9	8	0	7	0	0
December.....	26	45	40	4	14	4	3	1	0
1916.									
January.....	27	54	49	3	11	6	5	1	1
February.....	28	111	95	0	4	6	10	8	0
March.....	30	254	240	0	0	0	0	24	6
April.....	28	232	220	1	0	0	1	22	4
May.....	29	122	105	0	0	2	21	5	0
June.....	23	77	85	0	0	7	14	2	0
Total.....	314			32	51	46	98	75	12
Average.....		110	91						
Per cent.....				10.1	16.2	14.6	31.2	23.8	4.1

Month.	On litmus lactose agar at 37.5° C., 24 hours.—Acid formers.				
	Number of test days.	Number of tests.	Variations in numbers: Number of test days.		
			0.	1 to 3.	4 to 8.
1915.					
July.....	27	27	15	11	1
August.....	30	30	26	4	0
September.....	26	26	22	4	0
October.....	29	29	23	6	0
November.....	28	28	27	1	0
December.....	26	26	19	7	0
1916.					
January.....	29	29	25	4	0
February.....	29	29	27	2	0
March.....	31	31	30	1	0
April.....	29	29	29	0	0
May.....	29	29	21	6	2
June.....	24	24	17	6	1
Total.....	337	337	274	53	4
Average.....					
Per cent.....			81.3	17.5	1.2

<sup>1</sup> Copper sulphate treatment.

TABLE NO. 9.—Numbers of colonies per cubic centimeter in water delivered to mains Mount Hope purification plant.

Month.	On nutrient agar at 37.5° C., 24 hours.								
	Number of test days.	Mean per c. c.	Median per c. c.	Variations in numbers: Number of test days.					
				0 to 100.	101 to 300.	301 to 500.	501 to 700.	701 to 1,000.	Above 1,000.
1915.									
July.....	31	414	396	4	8	9	7	2	1
August.....	31	543	480	0	3	13	8	6	1
September.....	28	414	391	0	6	16	5	1	0
October.....	29	1,662	550	1	4	9	5	2	8
November.....	29	353	325	1	12	11	4	1	0
December.....	29	750	550	1	3	8	7	2	8
1916.									
January.....	31	868	750	1	0	5	6	10	9
February.....	29	798	900	8	1	2	1	6	11
March <sup>1</sup> .....	29	7	4	29	0	0	0	0	0
April.....	26	5	2	26	0	0	0	0	0
May.....	29	14	10	29	0	0	0	0	0
June.....	29	8	5	29	0	0	0	0	0
Total.....	350			129	37	73	43	30	38
Average.....		486	325						
Per cent.....				36.8	10.5	20.8	12.2	8.5	11.2

Month.	On litmus lactose agar at 37.5° C., 24 hours.								
	Number of test days.	Mean per c. c.	Median per c. c.	Variations in numbers: Number of test days.					
				0 to 10.	11 to 25.	26 to 50.	51 to 75.	76 to 150.	Above 150.
1915.									
July.....	25	12	9	15	8	2	0	0	0
August.....	29	54	11	14	7	3	1	0	4
September.....	27	63	45	1	4	9	7	5	1
October.....	27	71	26	7	5	5	4	3	3
November.....	29	8	5	23	4	2	0	0	0
December.....	27	47	14	9	7	4	3	1	3
1916.									
January.....	30	76	7	7	4	3	5	7	4
February.....	28	186	155	7	1	0	1	5	14
March <sup>1</sup> .....	29	1	1	29	0	0	0	0	0
April.....	24	2	1	24	0	0	0	0	0
May.....	29	4	4	28	1	0	0	0	0
June.....	22	5	4	20	2	0	0	0	0
Total.....	326			184	43	28	21	21	29
Average.....		44	8						
Per cent.....				56.4	13.1	8.6	6.4	6.4	9.1

Month.	On litmus lactose agar at 37.5° C., 24 hours—Acid formers.			
	Number of test days.	Number of tests.	Variations in numbers: Number of test days.	
			0.	1 to 5.
1915.				
July.....	27	27	27	0
August.....	30	30	30	0
September.....	29	29	29	0
October.....	29	29	29	0
November.....	30	30	30	0
December.....	28	28	27	1
1916.				
January.....	30	30	30	0
February.....	28	28	28	0
March <sup>1</sup> .....	29	29	29	0
April.....	24	24	24	0
May.....	29	29	28	1
June.....	22	22	21	1
Total.....	335	335	332	3
Per cent.....			99.1	0.9

<sup>1</sup> Application of liquid chlorine started.

TABLE NO. 10.—Numbers of colonies per cubic centimeter in water from distribution system supplied by Mount Hope purification plant.

Month.	On nutrient agar at 37.5° C., 24 hours.									
	Number of test days.	Mean per c. c.	Median per c. c.	Number of tests.	Variations in numbers: Number of test days.					
					0 to 100.	101 to 300.	301 to 500.	501 to 700.	701 to 1,000.	Over 1,000.
1915.										
July.....	31	375	359	62	7	17	26	7	4	1
August.....	29	459	427	58	0	9	26	14	8	1
September.....	29	562	435	58	0	9	32	10	2	0
October.....	27	2,060	450	54	1	13	16	6	4	14
November.....	27	487	350	53	1	20	24	8	0	0
December.....	31	624	600	61	1	11	14	11	14	10
1916.										
January.....	30	703	750	53	3	2	3	21	25	5
February.....	28	595	575	54	12	2	10	7	15	8
March <sup>1</sup> .....	30	39	9	60	53	5	2	0	0	0
April.....	29	31	14	71	65	6	0	0	0	0
May.....	29	114	71	80	51	24	4	0	1	0
June.....	28	162	61	68	50	14	4	0	0	0
Total.....	348			738	244	132	161	84	73	39
Average.....		517	205							
Per cent.....					33.0	17.8	21.8	11.3	9.8	5.3

Month.	On litmus lactose agar at 37.5° C., 24 hours.									
	Number of test days.	Mean per c. c.	Median per c. c.	Number of tests.	Variations in numbers: Number of test days.					
					0 to 10.	11 to 25.	26 to 50.	51 to 150.	Above 150.	
1915.										
July.....	26	19	10	51	28	9	10	4	9	
August.....	26	47	14	55	27	8	9	6	5	
September.....	22	64	37	46	2	14	14	11	5	
October.....	27	94	22	51	18	7	10	7	9	
November.....	27	6.2	4	52	44	7	1	0	0	
December.....	30	32	13	56	26	12	11	3	4	
1916.										
January.....	28	60	35	56	8	15	9	19	5	
February.....	28	94	82	50	12	4	2	22	10	
March <sup>1</sup> .....	31	3.5	1	61	54	7	0	0	0	
April.....	29	6.3	3	64	56	4	2	1	0	
May.....	29	13	8	85	53	19	11	2	0	
June.....	26	31	22	54	6	26	11	11	0	
Total.....	329			681	334	132	90	86	38	
Average.....		39	11							
Per cent.....					49.0	19.3	13.2	12.6	5.9	

Month.	On litmus lactose agar at 37.5° C., 24 hours.—Acid formers.				
	Number of test days.	Number of tests.	Variations in numbers: Number of test days.		
			0.	1 to 5.	Above 6.
1915.					
July.....	28	55	55	0	0
August.....	29	55	55	0	0
September.....	25	50	49	1	0
October.....	27	54	54	0	0
November.....	27	52	52	0	0
December.....	31	59	58	1	0
1916.					
January.....	29	57	57	0	0
February.....	27	54	54	0	0
March <sup>1</sup> .....	31	61	60	1	0
April.....	29	67	66	1	0
May.....	29	85	80	4	1
June.....	26	63	55	7	1
Total.....	338	712	695	15	2
Average.....					
Per cent.....			97.6	2.1	0.3

<sup>1</sup> Application of liquid chlorine started.

TABLE NO. 11.—Numbers of the members of the Colon group in the inflow and outflow at Mount Hope purification plant.

Month.	Raw water.										B. coli index. No. per liter.
	Number of test days.	0.1 c. c. tests.			1.0 c. c. tests.			10 c. c. tests.			
		Total num- ber.	Number +.	Per cent +.	Total num- ber.	Number +.	Per cent +.	Total num- ber.	Number +.	Per cent +.	
1915.											
July.....	31	10	0	0	31	16	51.6	31	26	83.8	548
August.....	31	27	3	11.1	31	11	35.5	30	23	76.6	1,396
September.....	29	28	3	10.7	29	13	44.8	29	24	82.7	1,449
October.....	30	30	0	0	30	12	40	30	18	60	420
November.....	30	30	2	6.6	30	13	43.3	30	25	83.3	1,067
December.....	31	31	1	3.2	31	16	51.6	31	29	93.5	846
1916.											
January.....	31	31	0	0	31	4	12.9	31	25	80.6	197
February.....	29	29	0	0	29	2	7.3	29	21	72.4	138
March.....	31	31	1	3.2	31	2	6.5	31	19	61.3	901
April.....	29	28	1	3.5	28	0	0	29	14	48.2	398
May.....	29	29	4	13.7	29	4	13.6	29	21	72.4	1,419
June.....	29	29	2	6.8	25	5	20	29	25	86.2	878
Total.....	360	333	17	.....	355	98	.....	359	260	.....	.....
Average.....				4.9			25.6			75.1	805

Month.	Water delivered to mains.								Water from taps on distribution system.							
	Number of test days.	1.0 c. c. tests.			10 c. c. tests.			B. coli index. No. per liter.	Number of test days.	1.0 c. c. tests.			10 c. c. tests.			B. coli index. No. per liter.
		Total num-ber.	Number +.	Per cent +.	Total num-ber.	Number +.	Per cent +.			Total num-ber.	Number +.	Per cent +.	Total num-ber.	Number +.	Per cent +.	
1915.																
July.....	31	30	0	0	30	9	30	30	30	60	1	1.6	60	11	18.3	33
August.....	31	30	0	0	30	0	0	0	31	58	1	1.7	57	10	17.5	33
September.....	29	29	5	17.2	29	11	38	193	28	56	7	12.5	56	19	33.9	146
October.....	30	30	1	3.3	30	11	36.5	66	29	57	0	0	57	13	22.8	23
November.....	30	30	1	3.3	30	6	20	23	27	53	6	11.3	53	10	18.8	120
December.....	29	29	0	0	29	0	0	0	31	61	1	1.6	61	6	9.8	24
1916.																
January.....	31	31	0	0	31	0	0	0	30	59	0	0	59	2	3.3	3
February.....	29	29	0	0	29	1	3.4	3.4	28	55	1	1.8	55	3	5.4	22
March.....	29	29	0	0	29	0	0	0	31	62	3	4.8	62	9	14.5	58
April.....	27	29	0	0	28	1	3.6	3.6	29	64	1	1.5	69	5	7.2	21
May.....	29	29	1	3.6	29	3	10.3	43	29	85	5	5.8	85	14	16.4	68
June.....	29	29	1	3.6	29	1	3.4	34	30	82	10	12.1	82	10	12.1	121
Total.....	354	354	9	.....	353	43	.....	.....	353	752	36	.....	756	112	.....	.....
Average.....	.....	.....	2.5	.....	.....	12.1	.....	33	.....	.....	4.5	.....	.....	15.0	.....	56



TABLE No. 12.—Numbers of colonies per cubic centimeter in raw water, *Agua Clara* purification plant.

Month.	On nutrient agar at 37.5° C., 24 hours.							
	Number of test days.	Mean per c. c.	Median per c. c.	Variations in numbers: Number of test days				
				0 to 100.	101 to 300.	301 to 700.	701 to 1,000.	Over 1,000.
1915.								
July.....	31	248	180	1	22	8	0	0
August.....	31	309	290	0	16	15	0	0
September.....	27	234	220	2	18	7	0	0
October.....	31	385	310	2	13	15	0	1
November.....	30	530	475	0	2	23	4	1
December.....	31	410	360	0	10	16	5	0
1916.								
January.....	31	230	240	2	21	8	0	0
February.....	29	556	550	0	1	22	6	0
March.....	31	517	480	0	11	12	6	2
April.....	29	322	240	1	19	7	1	1
May.....	28	678	550	0	6	11	6	5
June.....	27	634	400	0	7	16	2	2
Total.....	356			8	146	160	30	12
Average.....		421	324					
Per cent.....				2.2	40.0	43.4	8.5	3.3

Month.	On litmus lactose agar at 37.5° C., 24 hours.							
	Number of test days.	Mean per c. c.	Median per c. c.	Variations in numbers: Number of test days.				
				0 to 100.	101 to 300.	301 to 700.	701 to 1,000.	Over 1,000.
1915.								
July.....	31	98	90	1	1	16	12	1
August.....	28	93	81	0	3	16	8	0
September.....	21	70	68	0	5	13	3	1
October.....	30	95	48	0	18	7	4	1
November.....	30	130	125	1	2	10	11	6
December.....	31	205	260	0	3	8	3	17
1916.								
January.....	31	47	36	0	21	7	3	0
February.....	29	136	116	0	1	6	18	4
March.....	31	83	69	0	8	17	5	1
April.....	29	59	42	2	16	7	3	1
May.....	30	170	140	0	0	5	17	8
June.....	28	86	120	0	2	8	15	3
Total.....	349			4	80	120	102	43
Average.....		106	90					
Per cent.....				1.1	21.9	32.8	27.9	11.7

Month.	On litmus lactose agar at 37.5° C., 24 hours.—Acid formers.					
	Number of test days.	Number of tests.	Variations in numbers: Number of test days.			
			0.	1 to 3.	4 to 8.	Over 8.
1915.						
July.....	31	31	22	8	0	1
August.....	30	30	17	13	0	0
September.....	24	24	21	3	0	0
October.....	30	30	17	10	3	0
November.....	30	30	20	6	4	0
December.....	31	31	21	8	2	0
1916.						
January.....	31	31	30	1	0	0
February.....	29	29	28	1	0	0
March.....	31	31	29	1	1	0
April.....	30	30	24	2	4	0
May.....	30	30	5	7	2	16
June.....	28	28	12	12	4	0
Total.....	355	355	246	72	20	17
Average.....						
Per cent.....			67.2	19.7	5.5	4.6

TABLE NO. 13.—*Numbers of colonies per cubic centimeter in water delivered to mains, Agua Clara purification plant.*

Month.	On nutrient agar at 37.5° C., 24 hours.							
	Number of test days.	Mean per c. c.	Median per c. c.	Variations in numbers: Number of test days.				
				0 to 100.	101 to 300.	301 to 700.	701 to 1,000.	Over 1,000.
1915.								
July.....	31	229	182	7	17	7	0	0
August.....	31	470	365	2	10	13	2	4
September.....	28	284	248	2	14	10	1	0
October.....	31	329	280	2	14	14	1	0
November.....	30	343	330	1	13	15	1	0
December.....	31	341	300	2	14	12	1	2
1916.								
January.....	30	800	730	0	2	13	6	9
February.....	29	575	480	0	5	19	2	3
March.....	31	571	420	0	2	21	5	3
April.....	30	810	767	2	6	6	10	6
May.....	29	1,440	1,100	0	3	4	7	15
June.....	26	1,930	1,250	0	0	7	5	14
Total.....	357			19	100	141	41	56
Average.....		594	400					
Per cent.....				5.2	27.4	38.5	11.2	15.3

Month.	On litmus lactose at 37.5° C., 24 hours.							
	Number of test days.	Mean per c. c.	Median per c. c.	Variations in numbers: Number of test days.				
				0 to 10.	11 to 50.	51 to 100.	101 to 200.	Over 200.
1915.								
July.....	31	11	10	17	14	0	0	0
August.....	30	29	14	12	12	5	0	1
September.....	19	13	4	13	5	1	0	0
October.....	31	46	16	13	9	5	2	2
November.....	28	25	13	10	14	2	2	0
December.....	30	19	9	17	10	2	1	0
1916.								
January.....	31	201	90	4	8	5	2	12
February.....	29	85	42	1	16	4	6	2
March.....	30	44	27	3	19	6	1	1
April.....	30	36	21	9	15	5	0	1
May.....	31	24	7	19	9	1	1	1
June.....	28	105	9	16	4	0	4	4
Total.....	348			134	135	36	19	24
Average.....		36	16					
Per cent.....				36.6	36.9	9.9	5.2	6.6

Month.	On litmus lactose agar at 37.5° C., 24 hours—Acid formers.							
	Number of test days.	Number of tests.	Variations in numbers: Number of test days.					
			0.	1 to 3.	4 to 8.	Over 8.		
1915.								
July.....	31	31	29	2	0		0	0
August.....	30	30	29	1	0		0	0
September.....	27	27	27	0	0		0	0
October.....	31	31	30	1	0		0	0
November.....	30	30	30	0	0		0	0
December.....	31	31	31	0	0		0	0
1916.								
January.....	31	31	31	0	0		0	0
February.....	29	29	27	2	0		0	0
March.....	30	30	28	2	0		0	0
April.....	30	30	28	1	0		0	0
May.....	31	31	22	7	1		1	1
June.....	28	28	25	3	0		0	0
Total.....	359	359	337	19	1		1	1
Average.....								
Per cent.....			92.1	5.2	0.5			0.3

TABLE NO. 14.—Numbers of the members of the Colon group in the inflow and outflow at Aqua Clara purification plant.

Month.	Number of test days.	Raw water (Agua Clara Reservoir).									B. collindex. Num- ber per liter.
		0.1 c. c. tests.			1.0 c. c. tests.			10 c. c. tests.			
		Total number.	Number. +	Per cent. +	Total number.	Number. +	Per cent. +	Total number.	Number. +	Per cent. +	
1915.											
July.....	31	31	0	0	31	16	51.6	31	27	87.1	552
August.....	31	31	5	16.1	31	24	77.7	31	28	90.3	2,235
September.....	28	25	4	16.0	28	18	64.4	27	21	77.8	2,097
October.....	39	24	6	20.7	31	21	67.7	31	26	83.9	2,556
November.....	30	30	8	26.6	30	25	83.3	30	30	100	3,244
December.....	31	31	4	12.9	31	10	32	31	23	74.2	1,365
1916.											
January.....	30	27	0	0	30	1	3.2	30	12	40	688
February.....	29	29	0	0	29	0	0	29	7	24.1	24
March.....	31	31	0	0	31	5	16.1	31	17	54.8	248
April.....	30	30	0	0	30	6	20	30	12	40	220
May.....	31	31	0	0	31	9	29	31	20	64.6	326
June.....	30	30	2	6.67	30	10	33.3	30	25	83.3	383
Total.....	363	355	29		363	145		362	248		
Average.....				8.24			39.9			68.3	1,162

Month.	Water delivered to mains.								Water from taps on distribution system.							
	Number of test days.		1.0 c. c. tests.		10 c. c. tests.		Num- ber per liter.	Number of test days.		1.0 c. c. tests.		10 c. c. tests.		Num- ber per liter.		
			Total number.	Number. + Per cent. +	Total number.	Number. + Per cent. +				Total number.	Number. + Per cent. +	Total number.	Number. + Per cent. +			
	31	31	0	0	31	3	9.68	10	31	31	0	0	31	1	3.23	3
1915.																
July.....	31	31	0	0	31	3	9.68	10	31	31	0	0	31	1	3.23	3
August.....	31	31	1	3.23	31	7	22.60	52	31	31	2	6.46	31	3	9.68	68
September.....	27	27	0	0	27	1	3.71	4	20	20	1	5	20	1	5	50
October.....	31	31	0	0	31	0	0	0	29	29	0	0	29	0	0	0
November.....	30	30	1	3.33	30	1	3.33	33	30	30	1	3.33	30	1	3.33	33
December.....	31	31	1	3.23	31	4	12.90	10	10	10	1	10	10	1	10	100
1916.																
January.....	30	30	0	0	30	0	0	0	24	24	0	0	24	0	0	0
February.....	29	29	1	3.45	29	5	17.20	48	25	25	0	0	25	5	20	20
March.....	31	31	6	19.40	31	12	38.70	213	27	27	1	3.71	27	6	22.20	46
April.....	30	30	1	3.33	30	10	33.30	63	26	26	1	3.85	26	2	7.70	42
May.....	31	31	2	6.46	31	10	32.30	90	26	26	2	7.70	26	7	26.90	96
June.....	30	30	0	0	30	4	13.30	13	26	26	1	3.85	26	2	7.70	42
Total.....	362	362	13		362	57		45	305	305	10		305	29		
Average.....	.....	.....	.....	3.54	.....	.....	15.57	45	.....	.....	.....	3.66	.....	.....	9.64	42

TABLE NO. 15.—*Miraflores purification plant—Physical and chemical character of raw and filtered water.*

[Parts per million.]

Week ending—	Odor.		Color.		Turbidity.		Free carbonic acid (CO <sub>2</sub> ).		Alkalinity.		Soap hardness (as CaCO <sub>3</sub> ).		
			Apparent—raw.	True.									
	Raw.	Filtered.		Raw.	Filtered.	Raw.	Filtered.	Raw.	Filtered.	Raw.	Filtered.	Raw.	Filtered.
1915.													
July 3	3-v	1-v	44	13	Trace.	19	0	3.5	5.4	51.1	40.3	35.7	35.1
10	3-v	1-v	52	14	Trace.	22	0	3.4	6.7	46.5	36.8	32.5	33.1
17	3-v	1-v	81	13	0	31	0	3.4	6.7	46.3	35.2	31.8	31.8
24	3-v	1-v	46	11	Trace.	13	0	3.5	5.6	52.1	42.6	32.5	35.7
31	3-v	2-v	46	11	0	22	0	4.1	6.0	52.4	43.6	29.9	33.8
Aug. 7	3-v	1-v	52	12	0	16	0	3.9	5.7	49.8	39.5	35.5	36.4
14	3-v	1-v	46	11	0	9	0	4.3	6.6	49.3	38.4	33.8	36.4
21	3-v	1-v	22	10	0	4	0	3.9	5.6	51.8	42.1	35.8	35.1
28	3-v	1-v	27	10	0	4	0	4.4	4.3	52.7	46.1	31.7	29.6
Sept. 4	3-v	1-v	19	10	2	3	0	4.0	4.7	54.6	48.3	43.7	42.8
11	3-v	1-v	24	13	6	10	0	3.2	3.4	52.5	47.1	38.2	41.2
18	3-v	0-0	27	13	5	5	0	4.6	4.5	56.6	49.3	46.8	49.1
25	2-v	0-0	44	11	5	12	0	3.8	5.1	57.3	50.4	47.5	49.1
Oct. 2	2-v	0-0	50	8	1	16	0	4.8	5.6	58.1	50.0	44.1	42.1
9	2-v	0-0	48	14	3	13	0	5.5	5.2	54.5	48.2	44.7	57.1
16	2-v	0-0	48	16	5	16	0	4.5	6.5	57.6	47.1	43.1	46.8
23	1-v	0-0	41	18	3	11	0	4.9	5.7	59.5	51.1	47.1	47.1
30	3-v	0-0	45	17	0	10	0	4.0	5.5	60.5	47.5	43.2	46.2
Nov. 6	3-v	0-0	133	29	7	77	0	5.6	8.3	49.0	29.3	43.2	44.3
13	2-v	0-0	37	15	1	13	0	3.2	4.3	59.7	51.6	43.1	47.1
20	2-e	0-0	36	4	102	0	4.4	5.6	46.9	36.1	43.1	47.1	
Dec. 27	2-v	0-0	57	19	6	26	0	2.7	4.3	49.2	38.3	41.4	38.9
4	1-v	0-0	48	16	7	33	0	2.6	2.9	54.0	49.1	36.3	38.1
11	2-e	0-0	79	27	9	71	0	3.3	4.5	44.0	32.7	33.2	33.8
18	2-e	0-0	55	18	8	19	0	2.3	4.2	54.3	47.6	41.6	38.6
25	1-v	0-0	35	14	10	24	0	3.0	4.0	56.3	47.2	41.6	43.6
1916.													
Jan. 1	1-v	0-0	31	11	9	11	0	2.8	4.4	57.0	48.7	45.7	45.7
8	2-v	0-0	23	10	8	7	0	3.3	4.5	56.8	47.6	45.7	48.0
15	2-v	0-0	29	10	7	12	0	4.0	5.2	58.2	48.1	47.8	47.8
22	3-v	0-0	17	9	7	7	0	3.6	4.8	57.6	50.7	44.3	47.8
Feb. 29	4-e	0-0	11	8	6	2	0	3.5	4.6	57.6	49.6	45.0	48.6
5	3-v	0-0	13	8	6	2	0	3.7	4.2	53.5	45.6	45.7	46.4
12	3-v	0-0	12	4	4	7	0	3.6	5.0	52.7	46.6	46.4	45.7
19	2-v	0-0	11	5	2	2	0	3.7	3.8	56.5	51.3	50.7	47.8
26	3-v	0-0	12	5	3	2	0	2.9	3.3	53.9	51.7	47.8	47.1
Mar. 4	3-e	0-0	13	8	6	3	0	3.9	4.2	53.9	47.7	47.1	47.1
11	3-e	0-0	11	9	7	1	0	3.9	4.0	52.6	40.8	44.3	45.0
18	3-e	0-0	11	8	4	2	0	4.1	3.6	51.9	46.9	42.3	42.9
25	1-e	0-0	10	6	4	2	0	3.9	4.3	54.3	46.1	45.0	44.3
Apr. 1	2-e	0-0	11	6	3	3	0	4.9	4.0	52.1	48.0	43.6	42.3
8	3-e	0-0	14	8	4	6	0	4.9	4.9	53.6	47.6	42.3	43.6
15	2-e	0-0	14	6	5	4	0	4.9	4.4	52.2	40.2	40.3	42.3
22	1-e	0-0	15	11	7	2	0	4.6	4.8	50.3	45.5	42.3	42.9
29	2-v	0-0	18	9	9	6	0	5.0	5.6	50.0	42.4	42.3	41.0
May 6	2-e	0-0	15	9	4	5	0	5.4	5.2	48.8	40.4	38.0	40.3
13	3-e	0-0	24	15	5	7	0	4.0	6.3	46.0	37.0	38.6	40.3
20	2-v	0-0	22	11	5	5	0	4.6	5.1	43.4	36.3	33.1	34.5
27	2-v	0-0	26	12	4	5	0	4.6	5.1	40.3	31.4	31.2	31.8
June 3	2-e	0-0	35	13	2	21	0	4.0	6.4	39.4	29.0	31.8	31.8
10	2-v	0-0	34	14	3	8	0	4.6	5.9	40.1	30.5	37.7	33.8
17	2-e	0-0	53	15	3	11	0	3.9	6.4	40.7	30.7	33.8	33.8
24	1-e	0-0	39	18	2	7	0	3.7	6.5	43.1	31.4	36.4	33.8
July 1	2-e	0-0	37	16	2	9	0	3.2	4.7	49.1	40.1	40.3	38.7

TABLE No. 15.—*Miraflores purification plant—Physical and chemical character of raw and filtered water—Continued.*

[Parts per million.]

Week ending—	Oxygen consumed.		Oxygen dissolved.						Chlorine.	Total iron (Fe).		Solids.	
			Parts per million.		Per cent saturation.		Temperature.					Total.	
	Raw.	Filtered.	Raw.	Filtered.	Raw.	Filtered.	Raw.	Filtered.		Raw.	Filtered.	Raw.	Filtered.
1915.													
July 3	2.90	0.70	4.70	7.20	58.9	89.2	27.5	27.0	7.5	0.80	0.00	106	98
10	3.40	0.50	4.52	7.04	55.6	87.4	26.6	27.1	7.5	1.40	0.00	127	101
17	5.00	0.65	4.43	7.82	61.8	96.6	26.9	26.8	6.5	1.30	Trace.	104	93
24	2.50	0.65	4.43	7.65	64.9	94.5	27.1	26.9	7.5	1.70	0.00	109	95
31	2.60	0.50	4.97	7.40	61.1	91.7	26.6	27.0	7.0	0.70	0.00	119	95
Aug. 7	2.25	1.10	3.90	7.57	48.0	93.4	26.8	26.8	7.5	0.50	0.00	102	97
14	2.40	1.00	5.50	7.64	69.0	95.8	27.7	27.7	7.0	0.30	0.00	102	95
21	1.25	0.50	5.39	7.61	68.5	95.5	28.3	27.7	8.0	0.10	0.00	99	95
28	2.00	1.10	4.43	7.68	55.6	96.2	27.7	27.6	6.5	0.10	0.00	110	107
Sept. 4	2.30	1.50	4.89	7.52	62.0	95.4	28.4	28.1	9.0	Trace.	0.00	108	107
11	1.90	1.55	4.74	7.10	60.1	88.5	28.2	27.3	6.7	0.15	0.00	95	97
18	2.60	1.50	3.20	7.59	40.7	95.5	28.4	27.8	7.0	0.25	0.00	108	105
25	3.20	2.20	5.43	7.75	67.9	96.5	27.4	27.4	6.0	0.45	0.00	116	112
Oct. 2	2.30	1.30	5.30	6.42	66.2	79.3	27.5	26.8	4.8	0.65	Trace.	128	120
9	2.80	1.90	4.95	7.85	61.4	97.5	27.0	27.2	6.3	0.70	Trace.	121	124
16	2.10	1.30	4.83	8.25	59.5	101.5	26.8	26.5	5.5	0.80	0.00	121	114
23	2.20	1.40	6.18	7.88	77.0	97.7	27.5	27.2	6.5	0.10	0.00	113	117
Nov. 30	2.60	1.60	5.00	7.51	62.0	93.0	27.0	27.0	6.5	0.50	0.00	121	125
6	2.80	1.60	5.10	7.50	62.5	92.0	26.5	26.5	5.3	2.30	0.00	127	105
13	2.60	0.80	5.04	7.38	61.7	91.4	26.5	27.0	6.5	0.50	0.00	116	79
20	2.80	1.30	5.80	8.20	64.1	100.0	26.0	26.0	5.5	3.40	0.00	160	125
27	1.63	0.85	6.03	8.78	74.5	107.0	26.8	26.5	6.0	1.10	0.00	118	113
Dec. 4	1.90	1.20	7.20	7.44	66.2	96.5	26.0	26.0	7.2	1.30	0.00	142	129
11	2.55	1.15	5.40	7.98	66.5	99.5	26.8	27.2	4.8	2.00	0.00	182	136
18	2.60	1.30	5.73	7.70	71.3	95.5	27.3	27.0	7.3	0.75	0.00	127	123
25	1.60	0.80							6.5	0.60	Trace.	127	
1916.													
Jan. 1	1.40	0.90	5.15	7.35	65.0	91.3	28.0	27.1	8.0	0.40	0.00		
8	0.40	0.20	4.83	7.56	60.5	94.6	28.5	27.8	8.2	0.30	0.00		
15	0.95	0.05	4.97	7.45	63.2	93.2	28.2	27.4	9.0	0.20	0.00	121	133
22	0.80	0.40							8.5	0.30	0.00	117	123
Feb. 29	0.70	0.20	5.25	7.37	66.8	90.6	27.8	26.6	9.3	0.15	0.00		
5	0.55	0.05	5.30	7.78	69.0	95.8	27.6	26.6	9.0	0.00	0.00		
12	0.55	0.35							9.0	0.00	0.00		
19	1.55	0.45	5.09	7.65	63.3	94.8	27.3	27.0	9.0	0.00	0.00		
26	0.50	0.50	5.32	7.33	66.7	91.0	27.9	27.1	10.3	0.20	0.00		
Mar. 4	0.60	Trace.	4.98	7.29	62.6	90.0	27.8	26.8	8.5	0.10	0.00	117	109
11	1.00	0.65	4.78	7.47	60.5	92.9	28.0	27.2	8.5	Trace.	0.00	117	130
18	1.10	0.95	4.63	7.27	58.8	90.2	28.3	27.1	10.0	0.30	0.00	110	116
25	0.85	0.50	4.72	7.02	60.5	88.0	28.6	27.9	10.0	0.07	0.00	111	116
Apr. 1	0.75	0.25							9.0	0.10	0.00		
8	0.75	0.50	4.53	7.00	57.5	88.6	29.1	28.1	10.0	0.15	0.00		
15	1.35	1.15	4.61	7.10	58.8	89.7	28.6	28.1	9.0	0.15	0.00		
22	1.10	0.65	4.85	7.02	63.0	87.9			9.5	0.10	Trace.		
29	0.85	0.75			48.5	84.0	29.5	29.0	10.0	0.13	0.00	109	
May 6	1.15	0.40			49.2	85.4	29.0	28.5	9.0	0.15	0.00		
13	1.40	0.80	3.80	6.60	49.0	84.0	28.5	28.1	9.0	0.13	0.00		
20	1.85	0.95	4.75	6.90	61.3	88.1	28.9	28.8	10.0	0.20	0.00		
27	1.74	0.40	4.80	7.12	48.2	88.5	27.8	27.5	9.3	0.20	0.00		
June 3	2.75	0.75	4.40	7.10	56.6	91.7	29.0	29.2	8.0	0.60	0.00	103	122
10	2.00	1.00	4.55	7.24	58.5	92.8	29.0	29.0	7.0	0.25	0.00		
17	2.65	0.60	4.40	6.80	57.0	88.0	29.0	29.0	7.0	0.60	0.00		
24	2.05	0.25	5.10	7.30	53.5	91.0	29.0	29.5	6.3	0.40	0.00		
July 1	1.22	0.59	5.35	7.65	66.5	94.2	28.0	26.5	5.8	0.35	0.08	195	191

<sup>1</sup> Composite of samples collected during month.

TABLE NO. 15.—*Miraflores purification plant—Physical and chemical character of raw and filtered water—Continued.*

[Parts per million.]

Week ending—		Solids.		Nitrogen as—								
		Fixed.		Ammonia.				Nitrites.		Nitrates.		
				Free.		Albuminoid.						
		Raw.	Filtered.	Raw.	Filtered.	Raw.	Filtered.	Raw.	Filtered.	Raw.	Filtered.	
1915.												
July	3.	70	73	0.004	Trace.	0.092	0.00	-----	-----	0.08	0.04	
	10.	77	67	0.008	0.002	0.028	0.01	-----	-----	0.10	0.06	
	17.	66	70	0.040	0.032	0.088	0.042	0.002	0.000	-----	-----	
	24.	63	68	0.046	0.044	0.098	0.060	0.000	0.000	0.01	0.00	
	31.	76	-----	0.034	0.046	0.070	0.060	0.001	0.000	0.10	0.03	
	Aug.	7.	65	63	0.016	Trace.	0.093	0.000	Trace.	0.035	0.03	0.10
14.		70	71	0.006	0.022	0.000	0.020	Trace.	0.000	0.03	0.06	
21.		60	65	0.042	0.028	0.088	0.012	0.000	0.020	0.01	0.05	
	28.	72	60	-----	-----	-----	-----	0.000	Trace.	Trace.	Trace.	
	Sept.	4.	59	67	0.000	0.023	0.041	0.042	0.002	0.000	0.04	0.02
		11.	73	79	0.021	Trace.	0.056	0.015	0.002	0.002	0.06	0.02
18.		67	68	Trace.	0.003	0.046	0.020	0.002	0.002	0.04	0.06	
	25.	80	73	Trace.	0.006	0.050	0.016	Trace.	Trace.	0.02	0.025	
	Oct.	2.	95	84	0.009	0.005	0.045	0.008	0.003	Trace.	0.06	0.020
		9.	93	90	Trace.	Trace.	0.043	0.019	0.003	0.000	0.06	0.01
16.		89	91	0.009	0.009	0.042	0.014	0.001	Trace.	0.05	0.02	
	23.	78	53	0.008	0.008	0.030	0.005	0.002	0.000	0.02	0.02	
	30.	96	93	0.005	0.011	0.045	0.013	0.001	0.000	0.06	0.02	
	Nov.	6.	89	78	0.009	0.006	0.069	0.004	Trace.	0.000	0.08	0.08
13.		113	80	0.011	0.004	0.044	0.012	Trace.	Trace.	0.03	0.03	
20.		119	84	Trace.	0.010	0.084	0.012	0.000	0.000	0.10	0.08	
	27.	80	65	0.008	0.011	0.024	0.016	Trace.	0.000	0.04	0.05	
	Dec.	4.	108	98	0.000	0.009	0.042	0.012	0.003	0.000	0.00	0.00
		11.	87	63	0.009	Trace.	0.042	0.003	0.002	0.000	0.02	0.05
18.		87	-----	0.006	0.001	0.025	0.014	0.002	0.000	Trace.	Trace.	
25.	105	95	0.000	0.009	0.033	0.010	Trace.	0.000	0.02	0.01		
1916.												
Jan.	1.	-----	-----	Trace.	0.000	0.020	0.000	0.0025	Trace.	Trace.	Trace.	
	8.	-----	-----	0.000	-----	Trace.	-----	0.000	-----	Trace.	-----	
	15.	110	81	0.0020	0.008	0.040	0.012	0.002	0.000	0.00	Trace.	
	22.	99	101	0.0082	0.0023	0.034	0.0082	0.0005	0.000	Trace.	Trace.	
	29.	-----	-----	Trace.	0.000	0.026	0.004	Trace.	0.000	0.00	0.00	
	Feb.	5.	-----	-----	Trace.	0.0070	0.028	0.012	Trace.	0.000	Trace.	Trace.
12.		-----	-----	0.002	Trace.	0.022	0.012	0.001	0.002	0.00	Trace.	
19.		-----	-----	Trace.	Trace.	0.024	0.005	Trace.	Trace.	0.01	0.01	
	26.	-----	-----	0.0082	Trace.	0.034	0.017	Trace.	Trace.	0.02	0.01	
	Mar.	4.	88	94	-----	-----	-----	-----	0.0007	0.000	0.00	Trace.
		11.	90	91	Trace.	0.0076	0.019	0.014	Trace.	Trace.	0.01	0.012
18.		89	92	0.0029	Trace.	0.033	0.016	Trace.	Trace.	0.01	0.015	
	25.	89	92	0.0047	Trace.	0.029	0.012	Trace.	Trace.	0.013	0.004	
	Apr.	1.	-----	-----	Trace.	0.000	0.033	0.015	0.0015	0.0005	0.018	0.020
		8.	-----	-----	Trace.	0.011	0.027	0.015	0.0005	0.0005	0.020	0.015
15.		-----	-----	0.0071	Trace.	0.033	0.012	0.0008	Trace.	0.01	Trace.	
	22.	-----	-----	0.0090	0.0070	0.045	0.018	0.0005	0.0003	0.03	0.03	
	29.	183	-----	0.0082	0.0094	0.038	0.019	0.0005	0.0007	0.02	0.02	
	May	6.	-----	-----	0.0094	0.0047	0.041	0.019	0.0005	0.000	Trace.	0.01
13.		-----	-----	0.0071	0.0083	0.048	0.018	-----	-----	-----	-----	
20.		-----	-----	0.0083	Trace.	0.055	0.017	0.001	0.000	0.04	0.03	
	27.	167	176	Trace.	0.0035	0.047	0.007	0.0015	0.000	0.025	0.022	
	June	3.	-----	-----	0.0075	0.0027	0.063	0.011	0.001	0.000	0.02	0.015
		10.	-----	-----	0.0059	0.0083	0.074	0.023	0.000	0.000	0.025	0.020
17.		-----	-----	0.0047	0.0077	0.053	0.014	0.0013	0.000	0.050	0.06	
	24.	-----	-----	0.0071	0.0000	0.045	0.015	0.0010	Trace.	0.00	0.00	
	July	1.	161	159	0.0047	0.0000	0.046	0.011	0.0010	0.000	0.03	0.03

1 Composite of samples collected during month.

TABLE No. 16.—*Mount Hope purification plant—Physical and chemical character of raw and filtered water.*

[Parts per million.]

Week ending—		Odor.		Color.			Turbidity.		Free carbonic acid (CO <sub>2</sub> ).			Alkalinity (as CaCO <sub>3</sub> ).	
		Raw.	Filt- ered.	Appar- ent. raw.	True.		Raw.	Filt- ered.	Raw.	Aer- ated.	Filt- ered.	Raw.	Filt- ered.
					Raw.	Filt- ered.							
1915.													
July	10	1-g	0	26	5	0	8	0	3.0	0.0	3.0	36	28
	17	1-e	0	26	5	0	9	0	2.7	1.0	3.0	36	30
	24	1-e	0	35	5	0	12	0	3.7	2.0	3.2	33	28
	31	1-v	0	26	10	0	9	0	3.5	1.0	2.8	24	28
Aug.	7	1-v	0	22	5	0	4	0	0.5	0.0	2.5	34	28
	14	1-v	0	22	10	0	0	0	1.0	0.5	2.5	33	29
	21	1-v	0	16	5	0	3	0	0.0	0.0	2.0	33	28
	28	0	0	16	5	0	0	0	0.8	0.5	2.5	33	28
Sept.	4	1-v	0	16	5	0	0	0	1.0	0.5	3.0	32	27
	11	1-v	0	16	5	0	0	0	0.5	0.0	3.0	32	27
	18	1-v	0	16	5	0	0	0	0.5	0.0	3.0	33	28
	25	1-v	0	16	10	0	0	0	1.7	0.5	3.0	31	27
Oct.	2	1-v	0	35	10	5	4	0	0.5	0.0	3.4	31	23
	9	1-v	0	45	5	0	5	0	1.3	0.5	4.6	30	20
	16	1-f	0	60	5	5	3	0	4.0	1.0	5.0	28	17
	23	2-f	0	51	10	10	9	0	3.3	1.0	4.5	28	17
	30	1-v	0	60	10	0	10	0	3.1	0.7	4.0	28	20
Nov.	6	0	0	26	10	0	10	0	3.0	0.7	3.0	27	20
	13	0	0	26	10	0	0	0	2.6	1.0	3.0	27	19
	20	0	0	51	10	0	1	0	2.0	0.7	4.3	26	18
	27	1-v	0	60	10	0	8	0	2.3	0.5	4.0	25	17
Dec.	4	1-v	0	77	10	0	11	0	3.0	0.8	4.0	24	13
	11	1-v	0	70	10	0	10	0	3.0	0.6	4.4	22	12
	18	1-v	0	60	5	0	14	0	3.0	1.0	5.2	23	13
	25	1-v	0	65	5	0	12	0	1.0	0.5	5.0	24	13
1916.													
Jan.	1	2-v	0	45	10	0	17	0	0.5	0.5	5.0	26	14
	8	2-v	0	35	10	0	24	0	1.0	0.5	6.5	27	12
	15	1-m	0	22	5	0	22	0	0.5	0.0	7.7	30	14
	22	2-m	0	35	10	0	12	0	1.3	0.5	7.2	30	15
	29	1-v	0	35	5	0	9	0	1.9	0.5	7.0	31	17
Feb.	5	1-v	0	35	10	0	13	0	1.0	0.0	8.1	33	17
	12	1-v	0	35	10	0	13	0	0.9	0.0	7.5	35	18
	19	1-v	0	35	10	0	14	0	0.8	0.0	6.5	35	19
	26	2-v	1-v	35	10	0	15	0	0.5	0.0	6.5	36	18
Mar.	4	2-v	1-v	35	10	0	14	0	1.1	0.0	7.0	37	18
	11	2-v	0	35	10	0	12	0	1.5	0.5	7.3	36	19
	18	2-v	1-v	32	10	0	12	0	2.6	0.6	7.7	38	22
	25	2-v	1-v	32	10	0	11	0	2.4	0.7	6.7	39	23
Apr.	1	2-v	1-v	26	10	0	7	0	4.2	0.5	7.2	38	22
	8	2-v	1-v	22	10	6	7	0	2.9	0.5	4.9	41	28
	15	2-v	1-v	23	10	5	8	0	1.36	1.0	5.3	42	30
	22	2-v	1-v	23	8	6	9	0	3.5	1.0	4.5	44	34
	29	2-v	1-v	24	8	7	8	0	4.16	1.0	4.25	43	33
May	6	2-v	1-v	29	9	10	10	0	1.2	1.0	4.6	44	35
	13	2-v	1-v	33	8	10	9	0	2.6	1.0	6.6	43	32
	20	2-v	1-v	31	8	8	10	0	2.6	1.0	6.0	44	34
	27	2-v	1-v	26	8	7	9	0	1.6	1.0	6.2	42	33
June	3	2-v	1-v	25	5	7	10	0	0.5	1.0	5.8	43	32
	10	2-v	1-v	22	4	5	10	0	10.0	1.0	5.1	42	31
	17	2-v	1-cl	20	5	6	11	0	10.0	1.0	4.6	42	33
	24	1-v	1-cl	22	4	6	9	0	10.0	1.0	5.0	42	33
July	1	1-e	1-v	27	5	7	12	0	10.0	1.0	4.8	37	29

<sup>1</sup> Carbonate alkalinity 1.0-2.0 P.P.M.

TABLE No. 16.—*Mount Hope purification plant—Physical and chemical character of raw and filtered water—Continued.*

[Parts per million.]

Week ending—	Soap hardness (as CaCO <sub>3</sub> ).		Oxygen consumed.		Oxygen dissolved.						Chlorine.	Total iron (Fe).	
	Raw.	Filtered.	Raw.	Filtered.	Parts per million.		Per cent saturation.		Temperature.			Raw.	Filtered.
					Raw.	Filtered.	Raw.	Filtered.	Raw.	Filtered.			
1915.													
July 10.....	31.2	32.5	1.9	0.8	6.11	7.99	80.0	103	30.0	29.0	5.0	0.3	0.0
17.....	27.3	28.6	.....	.....	6.83	7.92	89.1	101	29.8	28.4	5.0	0.4	Trace.
24.....	27.3	28.6	2.1	0.6	6.66	8.15	86.5	105	29.6	29.1	5.0	0.75	0.25
31.....	29.9	29.9	1.7	0.6	7.30	8.40	95	106	29.1	28.2	5.0	0.40	0.0
Aug. 7.....	28.6	28.6	1.8	0.5	.....	.....	.....	.....	.....	.....	5.0	0.45	Trace.
14.....	27.3	27.3	1.9	0.8	8.04	8.65	105	110	29.9	28.6	5.0	0.35	0.0
21.....	28.6	28.6	1.6	0.6	7.76	8.15	103	107	30.4	30.0	5.0	0.25	0.0
28.....	28.6	28.6	1.6	0.5	8.09	8.49	107	109	30.3	29.1	5.0	0.20	0.0
Sept. 4.....	28.6	28.6	1.6	0.6	7.97	8.30	104	109	29.7	30.2	5.0	0.40	0.0
11.....	28.6	29.9	1.8	0.8	7.66	8.52	.....	.....	29.8	29.3	5.0	0.35	Trace.
18.....	28.6	28.6	1.8	0.7	9.00	8.41	119	109	30.2	29.5	5.0	0.30	Trace.
25.....	28.6	29.9	3.5	1.8	7.85	8.53	103	111	30.0	29.5	5.0	0.40	0.1
Oct. 2.....	27.3	27.3	3.0	0.8	.....	.....	.....	.....	.....	.....	5.0	0.4	0.1
9.....	27.3	27.3	4.0	1.0	8.15	8.75	106	112	29.8	28.5	5.0	0.4	0.05
16.....	26.0	26.0	3.5	0.9	7.56	8.60	98.8	109	29.8	28.0	5.0	0.65	0.1
23.....	26.0	27.3	3.1	1.4	5.35	8.43	68.2	108	28.5	28.5	5.0	0.8	0.2
30.....	26.0	27.3	2.6	0.6	6.43	8.40	83.5	108	29.5	28.8	5.0	0.6	0.0
Nov. 6.....	26.0	26.0	1.5	0.4	6.1	8.26	78.5	105	29.0	28.3	5.0	0.6	0.0
13.....	26.0	26.0	1.5	0.6	7.75	8.59	98.8	109	28.5	28.3	4.8	0.6	0.0
20.....	26.0	26.0	1.5	0.3	8.38	8.23	107	104	28.5	27.8	4.5	0.6	0.0
27.....	23.4	23.4	1.9	0.5	8.30	8.15	105	102	28.0	27.3	4.0	0.7	0.0
Dec. 4.....	22.1	22.1	.....	1.0	5.88	8.73	72.8	108	27.0	26.6	4.0	0.8	0.05
11.....	19.5	22.1	3.0	0.3	7.50	8.12	94.8	101	28.0	27.3	4.0	1.0	0.00
18.....	19.5	20.8	3.3	0.3	8.74	8.05	112	101	28.5	27.8	4.0	0.8	0.0
25.....	20.8	22.1	3.4	0.4	9.03	8.55	116	108	29.0	28.2	4.5	0.65	0.0
1916.													
Jan. 1.....	23.4	23.4	3.3	0.6	6.89	8.55	88.3	108	28.8	28.0	4.5	0.4	Trace.
8.....	24.7	27.3	4.0	0.3	6.72	7.74	.....	.....	29.6	28.4	4.5	0.4	Trace.
15.....	27.3	27.3	3.0	0.6	8.27	7.82	108	99	29.5	28.2	4.5	0.4	Trace.
22.....	24.7	26.0	3.8	0.9	5.07	7.27	64.7	96	28.7	28.2	4.5	0.4	Trace.
29.....	27.3	27.3	3.5	1.0	6.41	7.60	83.3	97	29.6	28.5	4.5	0.4	0.05
Feb. 5.....	29.9	31.2	3.8	0.8	6.72	7.98	86.1	100	28.8	27.5	5.0	0.6	0.0
12.....	29.9	31.2	4.1	1.1	6.82	7.92	87.5	99.4	28.8	27.7	5.0	0.5	0.15
19.....	29.9	29.9	4.0	0.9	7.05	8.65	89.0	107	28.0	27.0	5.0	0.4	0.1
26.....	32.5	32.5	4.5	1.4	6.82	8.65	85.0	108	27.3	27.3	5.0	0.4	0.1
Mar. 4.....	31.2	31.2	4.5	1.2	5.46	8.95	69	111	27.9	27.0	5.0	0.45	0.05
11.....	31.2	32.5	5.0	2.0	6.14	7.30	75	89	26.8	26.1	5.5	0.50	0.1
18.....	32.5	31.2	4.6	1.3	2.6	7.8	32	96	27.3	26.9	5.5	0.6	Trace.
25.....	33.8	35.1	4.4	1.3	4.6	8.3	57.6	101	27.6	27.1	6.0	0.4	Trace.
Apr. 1.....	36.4	37.7	4.0	0.9	1.75	8.34	22.2	104	28.3	27.5	6.0	0.65	Trace.
8.....	32.5	37.1	3.6	2.1	3.14	7.52	40.2	95	28.8	28.0	6.0	0.45	Trace.
15.....	38.0	41.6	3.5	1.8	5.6	8.08	71	101	28.4	27.8	6.0	0.25	0.1
22.....	38.0	40.3	3.7	2.3	4.31	8.07	54.4	101	29.0	28.3	6.5	0.25	Trace.
29.....	36.4	40.3	2.7	1.8	2.51	7.87	33.1	100	29.2	28.4	6.0	0.35	Trace.
May 6.....	32.5	37.7	3.3	1.3	5.42	7.83	70.4	100	29.6	28.6	6.5	0.40	0.05
13.....	37.7	40.3	3.4	1.8	3.20	7.5	41.0	94.7	28.8	28.0	6.5	0.40	0.15
20.....	32.5	37.7	4.2	2.0	5.87	7.68	75.2	96.9	29.0	28.0	6.5	0.45	0.10
27.....	36.4	38.0	4.2	2.1	6.35	7.71	81.2	97.3	28.7	28.0	6.5	0.30	0.10
June 3.....	33.8	36.4	4.3	2.9	7.71	7.71	99	97.7	29.1	28.1	6.5	0.25	Trace.
10.....	31.2	32.5	4.2	2.1	6.86	7.44	89	94	29.1	28.7	6.0	0.3	0.15
17.....	31.2	31.2	3.2	1.2	.....	.....	.....	.....	.....	.....	6.0	0.2	0.07
24.....	.....	.....	3.4	2.0	.....	.....	.....	.....	.....	.....	6.0	0.25	0.12
July 1.....	28.6	31.2	4.0	2.2	6.23	7.64	78	97	28.0	27.7	5.8	0.35	0.25



TABLE NO. 17.—*Agua Clara purification plant—Physical and chemical character of raw and filtered water.*

(Parts per million.)

Week ending—	Odor.		Color.			Turbidity.		Free carbonic acid (CO <sub>2</sub> ).		Alkalinity (as CaCO <sub>3</sub> ).		Soap hardness (as CaCO <sub>3</sub> ).	
	Raw.	Filtered.	Apparent—raw.	True.		Raw.	Filtered.	Raw.	Filtered.	Raw.	Filtered.	Raw.	Filtered.
				Raw.	Filtered.								
1915.													
July 3.....	1-v	0	40	5	0	40	0	2.5	5.5	19.0	7.0	16.9	18.2
10.....	1-v	0	40	5	0	25	0	3.5	6.0	19.0	10.0	19.5	18.2
17.....	1-v	0	35	0	0	22	0	2.0	6.0	19.0	10.0	18.2	18.2
24.....	1-v	0	35	5	0	20	0	0.0	5.0	19.0	10.0	18.2	18.2
31.....	1-v	0	35	5	0	18	0	3.0	4.0	19.0	11.0	16.9	18.2
Aug. 7.....	1-v	0	35	5	0	22	0	2.5	5.5	20.0	11.0	18.2	18.2
14.....	1-v	0	25	5	0	22	0	Trace.	4.5	18.0	10.0	15.6	15.6
21.....	1-v	0	37	5	0	22	0	0.25	4.0	19.0	10.0	15.6	15.6
28.....	1-v	0	35	14	0	22	0	1.0	4.0	16.0	8.0	15.6	15.6
Sept. 4.....	1-v	0	37	14	0	35	0	1.0	4.5	17.0	7.0	15.6	16.9
11.....	1-v	0	58	14	Trace.	35	0	0.0	4.0	17.0	5.0	15.6	15.6
18.....	1-v	0	60	16	5	35	0	1.0	4.0	18.0	8.0	16.9	16.9
25.....	1-v	0	60	16	5	35	0	2.5	4.0	17.0	9.0	16.9	18.2
Oct. 2.....	2-v	0	50	10	Trace.	45	0	2.0	4.0	16.0	6.0	16.9	15.6
9.....	1-v	0	55	5	0	40	0	2.0	5.0	17.0	6.0	16.9	16.9
16.....	1-v	0	43	7	3	30	0	2.0	5.5	17.0	4.0	14.3	18.2
23.....	1-v	0	50	15	5	27	0	2.5	5.5	18.0	9.0	15.6	18.2
30.....	1-v	0	45	5	0	23	0	3.0	6.0	18.0	7.0	14.3	16.9
Nov. 6.....	1-v	0	45	5	Trace.	22	0	3.5	6.0	17.0	6.0	12.7	14.3
13.....	1-v	0	40	5	0	20	0	3.0	6.0	17.0	5.0	14.3	15.6
20.....	1-v	0	35	5	0	20	0	3.5	5.5	17.0	9.0	12.7	15.6
27.....	1-v	0	30	7	1	21	0	3.0	6.0	18.0	8.5	12.7	15.6
Dec. 4.....	2-v	1-v	40	5	0	19	0	3.5	4.5	16.5	7.5	12.7	15.6
11.....	1-v	0	35	5	0	16	0	3.5	6.5	16.0	6.0	12.7	16.9
18.....	1-v	0	32	5	0	16	0	2.0	5.5	14.0	6.0	12.7	14.3
25.....	2-v	1-v	37	5	0	18	0	1.5	5.0	14.0	7.0	12.7	15.6
1916.													
Jan. 1.....	2-v	1-v	33	5	0	15	0	1.0	4.0	14.0	7.0	11.1	14.3
8.....	2-v	1-v	32	5	0	17	0	1.0	5.0	15.0	7.0	12.7	16.9
15.....	2-v	1-v	34	5	0	19	0	1.5	5.0	15.0	6.0	12.7	15.6
22.....	2-v	1-v	36	5	0	13	0	1.0	6.0	14.5	5.0	11.1	15.6
29.....	2-v	1-v	35	5	0	16	0	2.0	6.0	15.0	4.0	12.7	16.9
Feb. 5 <sup>1</sup> .....	2-v	1-v	35	5	0	16	0	1.5	4.5	15.0	9.0	12.7	14.3
12.....	2-v	1-v	50	10	4	16	0	2.0	3.5	15.0	12.0	12.7	18.2
19.....	2-v	1-v	58	9	7	19	0	2.0	3.5	16.0	15.0	18.2	18.2
26 <sup>2</sup> .....	2-v	1-v	63	9	14	22	0	2.0	3.0	17.0	14.0	15.6	23.4
Mar. 4.....	2-v	1-v	55	9	17	20	0	1.5	2.5	16.5	11.0	15.6	27.3
11.....	2-v	1-v	50	6	13	19	0	0.5	2.5	20.0	14.0	15.6	27.3
18.....	2-v	1-v	50	9	16	17	0	1.0	2.5	17.5	13.5	17.8	29.2
25.....	2-v	1-v	49	8	16	14	0	1.5	2.5	18.5	13.0	15.6	28.6
Apr. 1.....	2-v	1-v	50	17	18	18	0	1.0	2.5	18.5	15.0	19.2	31.3
8.....	2-v	1v 1e	55	10	23	19	0	1.0	1.5	20.0	16.5	24.6	28.1
15.....	3-e	1v 1e	50	6	21	17	0	3.5	4.0	20.0	15.0	19.6	28.8
22.....	3-e	1v 1e	55	5	24	14	0	3.5	3.5	20.0	14.5	24.7	27.6
29.....	3-e	1v 1e	55	7	17	13	0	2.5	3.5	20.0	14.0	18.8	33.0
May 6.....	3-e	1v 1e	65	6	13	15	0	4.0	5.5	19.5	11.0	11.0	21.2
13.....	3-e	1v 1e	60	8	15	16	0	4.0	4.5	19.5	14.0	15.2	23.2
20.....	3-e	1v 1e	65	9	12	17	0	4.5	4.5	20.0	12.0	15.0	24.1
27.....	2v 2e	2v 1e	70	9	9	18	0	5.5	3.5	19.5	13.5	13.9	26.6
June 3.....	2v 2e	1e 1v	90	8	8	19	0	8.0	4.0	20.0	14.5	13.8	24.4
10.....	2v 2e	1e 1v	80	7	7	14	0	6.0	3.5	20.5	14.0	13.9	24.1
17.....	2v 2e	1e 1v	65	6	7	14	0	6.0	6.5	19.5	10.5	13.9	23.8
24.....	2v 2e	1e 1v	70	5	5	15	0	4.5	4.0	19.0	11.5	11.9	21.7
July 1.....	2v 2e	1e 1v	86	7	5	17	0	6.0	3.0	20.0	15.5	13.5	26.0

<sup>1</sup> Application of soda ash started.<sup>2</sup> Application of lime started.

TABLE NO. 17.—*Agua Clara purification plant—Physical and chemical character of raw and filtered water—Continued.*

[Parts per million.]

Week end- ing—	Oxygen consumed.		Oxygen dissolved.						Chlorine.	Total iron (Fe).		Nitrogen as—			
	Raw.	Filtered.	Parts per million.		Per cent saturation.		Tempera- ture.			Raw.	Filtered.	Ni- trites.		Nitrates.	
			Raw.	Filtered.	Raw.	Filtered.	Raw.	Filtered.				Raw.	Filtered.	Raw.	Filtered.
1915.															
July 3.....	4.3	0.8	7.2	7.5	92.0	98.0	29.0	30.0	6.5	0.30	0.10				
10.....	4.3	1.0	6.2	6.1	81.0	80.0	30.0	29.5	6.0	0.40	0.20				
17.....	4.9	0.3	6.8	5.8	84.0	74.0	28.5	23.5	5.0	0.30	0.15				
24.....	3.9	0.9	7.8	6.9	99.0	88.0	28.0	28.5	5.0	1.00	0.20				
31.....	3.9	0.8							5.0	1.00					
Aug. 7.....	3.8	0.7	6.1	6.2	77.0	81.0	28.5	29.0	5.0	0.55	0.20				
14.....	3.7	0.9	8.03	7.28	106.0	96.0	30.6	30.1	5.0	1.40	0.55				
21.....	5.0	1.0	6.86	6.56	87.0	84.0	28.5	29.8	5.0	0.70	0.50				
28.....	5.0	0.9	6.33	6.62	79.0	83.0	27.5	27.5	5.0	0.70	0.30				
Sept. 4.....	5.3	0.5							5.0	0.70	0.20				
11.....	5.3	0.4							5.0	0.70	0.30				
18.....	5.0	0.9	7.5	6.8	96.0	87.0	28.5	29.0	5.0	0.70	0.20				
25.....	5.5	1.2							5.0	0.70	0.30				
Oct. 2.....	5.6	0.6							6.0	0.40	0.20				
9.....	4.8	0.7								0.60	0.20				
16.....	3.7	0.2	4.3	5.8	55.0	76.0	29.0	30.0	6.0						
23.....	3.8	0.2	5.2	6.6			27.0	28.0	6.0	0.50	0.10				
30.....	5.4	0.7	4.2	5.7	53.0	73.0	28.5	29.0	6.0	0.50	0.10				
Nov. 6.....	4.7	0.6	5.3	6.0	67.0	75.0	28.0	28.0	6.0	0.70	0.20				
13.....	5.2	0.7							6.0	0.40	Trace.				
20.....	4.2	0.4	5.2	5.6	66.0	70.0	28.5	28.0	6.0	0.55	0.10				
27.....	6.3	2.4	5.9	6.8	79.0	86.0	28.0	28.0	6.0	0.50	0.15				
Dec. 4.....	4.2	0.8	5.9	6.5	74.0	79.0	28.0	26.0	6.0	0.50	Trace.				
11.....	3.5	0.4	6.2	6.3	79.0	80.0	28.0	28.5	6.0	0.70	Trace.				
18.....	4.3	1.6	6.8	6.6	86.0	86.0	28.5	29.5	6.0	0.40	0.10				
25.....	3.4	0.3	7.3	7.2	93.0	92.0	28.5	29.0	6.0	0.30	0.10				
1916.															
Jan. 1.....	4.5	0.5	6.7	6.5	85.0	85.0	28.5	29.0	.....	0.30	Trace.				
8.....	5.0	1.2	6.9	6.9	88.0	88.0	28.5	28.5	6.0	0.40	Trace.				
15.....	4.4	0.8	6.7	6.9	84.0	87.0	28.5	28.0	6.0	0.35	0.15				
22.....	5.7	0.8	6.9	7.0	87.0	89.0	28.0	28.5	6.0	0.30	0.15				
29.....	4.5	1.0	6.7	7.0	86.0	88.0	29.0	28.2	6.0	0.45	0.15				
Feb. 5 <sup>1</sup> .....	4.4	1.3	6.9	7.1	89.0	91.0	29.0	29.0	5.5	0.25	0.10	0	0	Trace.	0
12.....	5.1	2.1	6.1	6.9	79.0	88.0	28.8	28.8	5.5	0.45	0.15	0	0		0
19.....	6.0	2.0	5.8	6.9	72.4	85.0	27.4	27.0	5.5	1.20	0.40	0	0	0	0
26 <sup>2</sup> .....	5.6	2.2	6.1	7.4	76.0	91.0	27.0	26.8	5.5	1.20	0.15	0	0	0	0
Mar. 4.....	6.3	2.3	7.2	7.6	89.0	93.0	26.8	26.5	5.5	0.70	0.45	0	0	0	0
11.....	8.5	2.7	8.16	7.45	91.0	93.0	27.7	27.6	6.0	1.20	0.40	0	0	0	0
18.....	8.95	4.55	7.77	7.37	99.4	94.6	28.7	28.9	6.0	0.85	0.30	0	0	0	0
25.....	7.45	4.20	6.54	6.51	82.4	81.6	27.9	27.6	6.0	0.80	0.60	0	0	0	0
Apr. 1.....	8.50	4.35	6.92	6.34	88.0	80.0	28.3	27.9	6.0	1.15	0.65	0	0	0	0
8.....	8.85	5.35	6.18	7.01	78.4	89.6	28.2	28.6	6.0	1.00	0.90	0	0	0	0
15.....	8.05	4.50	6.09	6.35	77.0	80.0	28.0	27.9	7.0	0.55	0.0	0	0	0	0
22.....	8.00	4.40	6.47	6.44	82.9	82.6	28.7	28.8		0.75	0.45	0	0	0	0
29.....	8.07	3.42	7.22	6.23	92.6	80.0	28.8	28.9	7.0	1.05	0.45	0	0	0	0
May 6.....	8.30	2.85	6.36	6.31	81.2	81.0	28.5	28.8	6.0	1.45	0.40	0	0	0	0
13.....	7.80	2.25	6.91	5.61	89.0	72.2	29.0	29.0	7.0	1.05	0.30	0	0	0	0
20.....	7.60	2.50	5.40	6.31	68.9	80.0	28.5	28.2	7.0	1.30	0.35	0	0	0	0
27.....	7.40	3.10	6.22	6.70	79.5	85.0	28.6	28.2	7.5	1.35	0.20	0	0	0	0
June 3.....	6.65	2.05	4.09	6.23	52.3	79.1	28.0	28.2	7.5	1.80	0.35	0	0	0	0
10.....	6.15	1.80	5.11	6.94	65.4	88.6	28.7	28.5	6.5	1.20	0.10	0	0	0	0
17.....	6.40	1.90	6.19	6.71	79.2	85.0	28.7	28.2	7.0	1.35	0.10	0	0	0	0
24.....	6.55	1.95	4.89	6.63	63.0	86.1	29.0	29.5	7.0	1.70	0.15	0	0	0	0
July 1.....	6.00	1.90	3.93	6.84	48.6	85.1	26.9	27.2	7.0	1.45	0.10	0	0	0	0

<sup>1</sup> Application of soda ash started.<sup>2</sup> Application of lime started.

TABLE NO. 18.—Physical and chemical character of water from Comacho Reservoir.

[Parts per million.]

Date.	Elevation of reservoir.	Odor.		Color—				Turbidity.		Free carbonic acid (CO <sub>2</sub> ).	
				Apparent.		True.					
		Surface.	Pump station.	Surface.	Pump station.	Surface.	Pump station.	Surface.	Pump station.	Surface.	Pump station.
1915.											
July 9.	342.8		3-v		11		11		10		
16.	341.4		3-v		28		15		20		6.5
23.	342.6		3-v		24		13		20		
Aug. 5.	345.8		3-v		80		18		15		
21.	345.7		3-v		20		10		15		
28.	346.8		3-v		21		13				
Sept. 10.	346.5		2-m		24		14				5.5
22.	350.0		4-m		90		7				1.0
28.	351.5		4-v		70		15				11.0
Oct. 5.	353.3		5-p		26		14		5		4.5
12.	357.2		3-p		60		20		15		13.0
19.	357.7		5-p		37		14		10		14.5
26.	360.8		5-p		160		60		20		15.5
Nov. 8.	366.7		5-p		140		37				14.5
16.	366.6		3-e		170		60		15		13.0
23.	366.4		3-e		150		14		15		12.5
Dec. 1.	365.3		4-d		150		17		20		13.0
7.	365.5		4-d		110		13		7		15.5
15.	366.2		4-e		134		40		17		17.5
21.	365.7		4-H <sub>2</sub> S		130		40		15		16.5
23.	365.6		4-H <sub>2</sub> S		115		15		15		25.0
27.	365.2	2-v	4-H <sub>2</sub> S	20	100	18	48	6	15	3.0	22.0
30.	364.8		4-H <sub>2</sub> S		90		37		10		21.0
1916.											
Jan. 4.	364.2	4-e	4-H <sub>2</sub> S	17	90	13	17	4	10	2.0	23.0
11.	363.2	3-e	4-e	17	70	12	22	7	11	2.5	20.0
18.	362.3	1-v	4-H <sub>2</sub> S	14	45	8	14	5	7	2.2	21.7
25.	361.1		4-H <sub>2</sub> S		37		8		20		15.0
Feb. 2.	359.9	2-v	4-v	12	15	8	8		7	2.2	6.6
8.	359.0			14	17	12	12	5	2	1.0	6.5
15.	358.0	0-0	1-a	13	15	8	11	2	2	4.0	1.5
23.	356.8	4-e	4-e	12	12	8	8	5	5	2.0	3.0
29.	355.8	3-v	3-v	18	15	10	9	2	2	4.5	3.0
Mar. 7.	354.6	4-m	4-m	15	15	10	10	2	2	6.0	6.5
14.	353.4	3-m	3-m	15	15	10	10	2	2	2.0	6.0
21.	351.9	1-m	3-m	11	12	9	9	1	1	2.5	4.0
28.	350.2	0-0	3-e	12	12	8	9	2	2	6.0	2.5
Apr. 4.	348.7	1-e	3-e	10	17	5	8	4	5	14.0	2.0
11.	347.1	1-e	2-f	17	18	11	10	2	2	1.0	2.5
18.	345.5	1-m	1-m	18	24	11	11	2	2	1.0	2.0
26.	343.7	0-0	0-0	24	22	11	13	7	5	0.0	0.0
May 2.	342.1		2-g		20		10		5		1.5
9.	340.2	0-0	4-H <sub>2</sub> S	11	20	8	10	2	15	0.8	41.3
16.	338.3	1-e	4-H <sub>2</sub> S	17	84	10	13	5	16	0.6	22.0
23.	336.7	0-0	3-H <sub>2</sub> S	17	24	10	10	5	10	1.0	12.0
31.	337.3	0-0	4-H <sub>2</sub> S	30	110	10	13	5	11	1.5	17.0
June 6.	335.6	1-e	2-H <sub>2</sub> S	15	26	13	15	7	15	1.5	12.0
13.	333.7	1-e	3-m	17	17	15	11	5	7	0.8	8.5
20.	333.6	2-e	4-H <sub>2</sub> S	35	80	16	18	5	9	0.6	8.5
27.	334.4	3-e	4-H <sub>2</sub> S	45	140	15	26	5	40	16.0	1.5

<sup>1</sup> Carbonate alkalinity.

TABLE NO. 18.—*Physical and chemical character of water from Comacho Reservoir—Contd.*

[Parts per million.]

Date.	Alkalinity (as CaCO <sub>3</sub> ).		Soap hard- ness (as CaCO <sub>3</sub> ).		Oxygen consumed.		Oxygen dissolved.				Tempera- ture.	
							Parts per million.		Per cent satu- ration.			
	Surface.	Pump sta- tion.	Surface.	Pump sta- tion.	Surface.	Pump sta- tion.	Surface.	Pump sta- tion.	Surface.	Pump sta- tion.	Surface.	Pump sta- tion.
1915.												
July 9.....		70.8		61.8								
16.....		61.0		47.1								
23.....												
Aug. 5.....		55.0		53.1								
21.....		59.5		36.8								
28.....		54.0		47.5								
Sept. 10.....		54.5				3.95						
22.....		55.5				5.00						
28.....		54.0				6.00						
Oct. 5.....		56.0		31.0		4.00						
12.....		53.5		38.9		4.80						
19.....		56.5		36.1		7.00						
26.....		56.0		39.1		7.20						
Nov. 8.....		46.0		36.4		7.50						
16.....		43.2		28.8		5.00						
23.....		48.0		30.4		4.00						
Dec. 1.....		48.6		34.2		4.70						
7.....		53.0		29.2		4.85						
15.....		52.0		37.4		5.20						
21.....		58.5		33.8		4.75						
23.....		54.5		35.1		4.40		0.00		0.00		
27.....	54.0	53.5	42.3	38.0	2.70	4.20	5.72	0.00	72.2	0.00	28.0	28.0
30.....		54.5		45.0		4.55		5.15		65.00		28.0
1916.												
Jan. 4.....	52.5	55.0	42.2	40.9	3.15	3.75	7.20		88.0		26.7	
11.....	56.3	57.2	47.8	47.1	2.90	3.55	6.25	0.36	79.5	3.20	28.4	26.5
18.....	57.5	61.5	42.9	42.3	3.35	3.50	7.15	0.20	90.0	2.50	28.0	27.2
25.....		59.0		51.4		3.45						
Feb. 2.....	56.0	56.0	50.0	42.9	2.65	2.85	5.55	3.30	70.0	41.3	28.0	27.5
8.....	59.0	59.0	47.1	47.1	3.35	2.15	6.01	3.96	75.0	49.1		
15.....	61.0	62.0	47.1	48.6	2.95	2.65	7.92	6.05	99.0	75.5	27.5	27.5
23.....	61.5	62.0	49.3	47.8	2.50	2.30	6.41	4.30	81.0	53.7	28.0	27.5
29.....	62.0	62.0	49.3	51.3	3.10	2.30	3.94	5.46	49.5	68.4	27.2	27.2
Mar. 7.....	62.0	62.0	52.9	52.1	2.20	1.25	4.72	3.90	58.5	38.4	27.0	27.0
14.....	63.0	62.5	50.0	50.0	2.20	1.85	7.44	3.14	93.8	39.3	28.0	27.5
21.....	63.0	63.0	49.3	47.8	2.90	2.25	6.75	4.75	84.5	59.4	27.5	27.5
28.....	63.5	66.0	51.4	51.4	2.55	3.30	7.72	5.29	87.4	66.7	28.0	28.0
Apr. 4.....	65.0	64.0	52.1	52.1	3.55	3.10	8.33	6.25	107.0	79.5	29.0	28.5
11.....	63.5	61.0	50.0	50.0	2.95	3.10	6.20	5.41	78.1	68.3	28.0	28.0
18.....	63.5	63.5	50.7	48.6			7.65	6.13	98.5	78.9	29.0	29.0
26.....	65.0	64.0	51.4	52.1	3.60	3.05	8.15	6.36	108.0	83.2	30.5	30.0
May 2.....		64.0		48.6		3.40		5.06		65.1		29.0
9.....	64.0	71.0	50.0	37.7	3.80	5.75	8.03	0.00	104.2	0.00	29.5	27.5
16.....	63.0	69.0	52.2	51.4	3.65	4.20	9.03	0.00	117.0	0.00	29.5	28.5
23.....	61.0	65.0	51.4	53.6	4.30	4.60	9.05	0.00	119.0	0.00	30.0	28.5
31.....	57.0	55.0	47.9	44.3	4.65	4.90	6.83	0.00	88.0	0.00	29.0	27.5
June 6.....	58.5	59.5	45.7	48.6	4.40	4.20	6.86	0.00	86.5	0.00	28.0	27.5
13.....	59.5	62.0	49.3	52.1	4.33	3.93	11.18	0.70	144.0	8.90	29.0	28.5
20.....	58.0	56.0	47.1	47.1	4.10	4.20	11.00	0.00	141.0	0.00	29.0	28.5
27.....	57.0	53.0	42.3	41.0	5.0	5.20	9.16	0.00	114.5	0.00	27.5	27.0

TABLE NO. 18.—Physical and chemical character of water from Comacho Reservoir—Contd.

[Parts per million.]

Date.	Chlorine.		Total solids.				Total iron (Fe).		Nitrogen as—			
			Total.		Fixed.				Nitrites.		Nitrates.	
	Surface.	Pump station.	Surface.	Pump station.	Surface.	Pump station.	Surface.	Pump station.	Surface.	Pump station.		
1915.												
July 9.	5.5		125		76		0.05					
16.	5.8		137		70		0.90					
23.												
Aug. 5.	5.5		135		75		0.80					
21.	5.8		135		72		0.25					
28.	5.3		116		72		0.40					
Sept. 10.	5.3		119		65		0.25		0.003		0.02	
22.	4.5		125		54		1.60		Trace.		0.01	
28.	5.0		125		78		1.40		Trace.			
Oct. 5.	5.0		112		70		0.40		0.004		0.02	
12.	4.8		113		80		1.40		0.002		0.01	
19.	5.0		114		76		0.50		0.002		Trace.	
26.	5.0		137				2.60		0.003		0.05	
Nov. 8.	5.0		117		68		1.60		0.003		Trace.	
16.	4.5		121		87		2.30		0.000		0.03	
23.	4.5		112		78		2.70		Trace.		0.03	
Dec. 1.	4.8		97		74		3.60		Trace.		0.00	
7.	5.3		118		91		2.90		0.002		0.00	
15.	4.2		114		78		3.40		0.003		0.00	
21.	5.5						3.50		0.0035		0.00	
23.	5.0						3.30		0.000		0.00	
27.	4.80	5.0					0.00	4.00	Trace.	0.00	0.00	
30.	4.8						2.20		Trace.		0.00	
1916.												
Jan. 4.	5.50	5.5					0.10	2.00	0.000	0.000	0.00	0.00
11.	5.00	5.2					0.10	2.00	0.000	Trace.	0.00	0.00
18.	5.30	5.3	108	117	73	78	0.00	1.00	0.001	Trace.	0.00	0.00
25.		5.5						1.20		Trace.		0.00
Feb. 2.	6.00	5.5					Trace.	0.30	0.000	Trace.	0.00	0.00
8.	5.50	6.0					0.25	0.45	0.001	0.001	0.00	0.00
15.	5.50	5.5					0.15	0.15	Trace.	Trace.	Trace.	0.00
23.	5.80	5.8					0.10	0.10	0.000	0.000	Trace.	Trace.
29.	6.00	6.0					0.30	0.25	0.0007	0.0007	Trace.	Trace.
Mar. 7.	6.00	6.0	110	104	90	94	0.25	0.40	0.0008	0.0008	Trace.	Trace.
14.	5.50	5.5	112	106	78	70	0.20	0.25	0.0008	0.001	0.025	0.02
21.	5.00	5.5	119	119	101	105	0.10	0.20	0.0008	0.001	0.01	0.01
28.	5.30	5.0	210	200	172	175	0.10	0.20	0.001	0.0005	0.01	0.01
Apr. 4.	5.00	5.0	194	106	146	75	0.20	0.30	0.0008	0.0008	0.01	0.00
11.	6.00	6.3	167	145	52	54	0.20	0.20	0.000	0.000	Trace.	0.008
18.	6.00	6.0					0.30	0.30	0.000	0.001	Trace.	Trace.
26.	5.00	5.0	115	113	72	72	0.20	0.00	Trace.	0.0008	Trace.	0.01
May 2.		5.5		126		89		0.13		0.001		0.00
9.	5.30	5.3	124	146	70	88	0.10	1.30	0.000	0.000	0.00	0.00
16.	5.70	6.0					0.23	2.80	0.000	0.000	0.01	0.07
23.	5.50	5.5					0.15	1.25	0.000	0.000	0.00	0.00
31.	6.30	6.3	<sup>1</sup> 158	<sup>1</sup> 211	<sup>1</sup> 115	<sup>1</sup> 165	0.45	2.25	0.000	0.000	0.00	0.00
June 6.	5.00	5.0					0.20	1.00	0.0008	Trace.	Trace.	0.00
13.	5.00	5.0					0.30	0.63	0.000	0.000	0.00	0.00
20.	5.30	4.8					0.40	1.30	0.000	0.000	0.00	0.00
27.	4.80	4.8	<sup>1</sup> 113	<sup>1</sup> 198	<sup>1</sup> 71	<sup>1</sup> 146	0.60	1.00	0.001	0.001	0.00	0.00

<sup>1</sup> Composite of samples collected during month.

TABLE NO. 19.—Rio Grande Reservoir—Physical and chemical character of water.

[Parts per million.]

Date.	Elevation.	Odor.	Color.		Turbidity.	Free carbonic acid (CO <sub>2</sub> ).	Alkalinity (CaCO <sub>3</sub> ).	Soap hardness (CaCO <sub>3</sub> ).	Oxygen consumed.	Nitrogen as—		Chlorine.	Solids.		Iron (Fe).
			Apparent.	True.						Nitrites.	Nitrates.		Total.	Fixed.	
1915.															
July 2	230.12	3-v	37	15	5	.....	57.0	39.6	.....	.....	.....	6.0	.....	.....	0.25
29	233.87	3-v	24	17	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.40
Aug. 28	235.75	3-H <sup>2</sup> S.	61	14	.....	.....	48.5	39.6	.....	.....	.....	4.7	119	72	0.45
Sept. 14	235.71	0-0	44	14	.....	10.0	82.0	.....	3.10	0.002	0.00	6.0	145	111	0.25
15	235.69	3-v	110	26	.....	12.0	49.0	.....	7.60	.003	0.03	5.0	116	77	2.80
23	235.80	5-m	150	8	.....	14.5	49.0	.....	8.80	Trace.	0.04	6.7	109	73	3.00
Oct. 6	235.87	5-p	200	70	30	12.0	44.5	30.3	9.40	0.002	.03	5.0	129	80	3.00
13	236.44	5-p	225	100	20	11.5	42.0	33.8	7.20	Trace.	.05	5.3	117	73	3.00
15	236.64	5-p	200	80	15	11.5	38.0	29.0	7.80	.003	.04	5.0	121	78	2.80
27	237.06	5-p	200	75	20	9.0	40.0	32.5	6.20	.003	.03	4.5	124	67	1.20
Nov. 4	237.99	5-p	240	40	20	7.5	29.5	31.2	5.70	.003	.03	3.7	118	77	1.90
9	238.16	5-p	175	65	.....	7.0	35.0	23.7	5.80	.004	.02	5.5	133	96	2.90
17	238.03	3-e	230	45	15	7.5	30.5	28.8	5.10	.000	.04	4.5	116	74	2.70
24	238.80	4-e	210	40	25	5.5	33.0	26.7	5.80	.003	.03	4.5	111	75	2.70
Dec. 1	235.91	3-e	200	40	18	5.5	34.0	29.0	4.60	.004	.00	5.0	105	63	2.00
8	237.01	2-e	160	32	18	7.0	38.5	23.0	4.45	.003	.00	4.5	107	69	2.00
16	236.74	3-e	134	37	13	6.0	38.3	26.0	4.30	.0035	.00	5.0	105	67	1.60
22	237.62	2-e	80	20	10	8.5	43.5	28.9	4.30	.000	Trace.	5.3	.....	.....	3.30
29	238.06	3-v	60	18	6	8.0	43.0	31.2	3.30	Trace.	Trace.	4.5	.....	.....	1.80
1916.															
Jan. 5	238.40	4-e	40	20	6	16.0	46.3	31.2	3.70	.000	.00	5.7	.....	.....	0.20
12	238.57	5-v	28	16	5	6.3	49.0	37.7	1.80	Trace.	.00	5.2	.....	.....	0.40
21	238.56	4-e	24	17	3	4.5	55.0	46.4	1.70	Trace.	.00	5.0	125	78	0.35
26	238.50	3-e	17	17	3	5.5	53.0	42.2	2.80	.001	.00	5.0	.....	.....	0.40
Feb. 5	238.41	4-e	28	14	3	6.5	52.0	41.0	2.65	.0005	.00	5.0	.....	.....	0.35
12	238.32	4-v	17	15	3	4.5	55.0	40.3	2.70	.001	.00	5.5	.....	.....	0.30
15	238.28	1-a	15	12	4	5.0	57.0	47.1	2.95	Trace.	Trace.	5.5	.....	.....	0.15
24	238.20	3-v	10	5	3	3.5	58.5	40.3	3.80	.001	Trace.	5.8	.....	.....	0.10
29	237.67	2-e	15	10	2	3.0	57.0	45.0	2.70	.003	Trace.	5.5	.....	.....	0.20
Mar. 18 <sup>2</sup>	.....	1-v	17	10	2	5.0	59.0	43.6	2.60	.0007	.02	5.5	102	80	0.10
18 <sup>2</sup>	.....	0-0	15	12	1	4.5	59.0	45.7	2.35	.0007	.01	6.0	103	69	0.20
21	233.56	1-m	14	10	3	4.0	58.0	46.4	2.85	.0007	.01	6.0	106	74	0.10
29	232.38	1-m	15	8	3	3.0	61.0	45.7	2.85	.0005	.01	6.0	94	77	0.10
Apr. 5	229.09	4-v	17	11	4	2.5	60.0	46.4	3.55	Trace.	.00	5.5	166	123	0.15
12	229.00	5-v	17	11	2	3.0	60.0	46.4	3.15	.005	.005	6.5	202	144	0.25
19	228.88	1-e	17	10	2	2.5	60.5	.....	.....	.004	.00	.....	.....	.....	0.20
27	228.72	0-0	18	11	4	0.0	63.0	47.1	2.35	.001	.00	6.0	106	65	0.15
May 3	228.74	3-e	15	10	2	0.0	61.5	50.0	2.90	Trace.	.01	5.5	121	88	0.18
10	228.64	0-0	15	13	2	0.0	60.0	47.6	3.40	.0005	.00	5.0	107	63	0.25
17	228.79	2-e	15	11	3	1.5	61.0	47.8	2.15	.000	Trace.	5.5	.....	.....	0.23
24	229.39	0-0	15	12	2	2.5	59.0	47.1	1.10	Trace.	.00	6.0	115	83	0.12
June 1	232.09	2-e	17	15	3	2.5	58.5	47.1	4.40	.000	.00	6.0	.....	.....	0.16
7	229.84	1-e	18	12	3	4.0	58.0	46.4	3.30	.000	Trace.	5.0	.....	.....	0.25
14	227.67	1-e	18	15	2	0.0	58.0	50.0	4.23	Trace.	.00	5.0	.....	.....	0.25
21	227.45	3-e	22	17	3	2.0	54.0	45.7	4.00	.000	.00	5.3	.....	.....	0.13
28	228.14	3-e	45	24	3	7.0	48.0	40.6	4.40	Trace.	Trace.	4.6	118	78	0.55

<sup>1</sup> Carbonate alkalinity = 4.0.<sup>2</sup> Zion Hill Reservoir.<sup>3</sup> Composite of samples collected during month.

TABLE No. 20.—*Mineral analyses.*  
[Parts per million, Analyst H. F. Schmidt.]

Source.	Date of collection.	Soluble solids.		Silica (SiO <sub>2</sub> ).	Iron (Fe).		Aluminum (Al).	Calcium (Ca).	Magnesium (Mg).	Sodium (Na).	Potassium (K).	Sodium and potassium (Na+K).	Carbonate radicle (CO <sub>3</sub> ).	Bicarbonate radicle (HCO <sub>3</sub> ).	Nitrate radicle (NO <sub>3</sub> ).	Nitrate radicle (NO <sub>2</sub> ).	Phosphate radicle (PO <sub>4</sub> ).	Chlorine (Cl).	Sulphate radicle (SO <sub>4</sub> ).	Remarks.
		Total.	Fixed.		Total.	Soluble.														
Mount Hope purification plant: Raw water (Brazos Brook Reservoir). Filtered water (delivered to mains). Agua Clara purification plant.	1915. Nov. 1-30	72	.....	11.80	0.550	0.10	0.86	7.58	2.60	5.90	1.95	.....	0	19.60	.....	.....	0.03	6.30	2.53	Monthly composite of daily samples.
	do.....	83	.....	10.35	.050	.05	.62	6.97	2.40	4.61	1.94	.....	0	7.61	.....	.....	.00	6.50	13.75	Do.
	Dec. 1-31	56.5	.....	14.90	.600	.....	.83	3.84	1.53	3.92	1.34	.....	0	9.79	.....	.....	.04	7.30	2.49	Do.
Miraflores purification plant: Raw water (Chagres River). Filtered water (delivered to mains).	do.....	54.5	.....	13.70	.140	.....	.08	5.01	1.44	3.89	1.21	.....	0	3.66	.....	.....	Trace.	7.80	6.33	Do.
	July 1-31	103	.....	25.30	.400	.....	.61	13.20	3.90	6.07	1.92	.....	0	29.1	0.321	0.0034	0.171	7.00	2.74	Do.
	do.....	99	.....	21.20	.000	.00	.40	12.40	3.60	4.20	1.75	.....	0	23.6	0.144	0.0000	Trace.	7.40	14.90	Do.
Raw water (Chagres River). Filtered water (delivered to mains). Camacho Reservoir. Rio Grande Reservoir. Palo Seco Leper Asylum. Wall near U. S. Lookout Station, Point Batele. Chiriqui River near David. Core suckers.....	1916. Mar. 1-31	115	87	23.85	.060	.03	.315	12.15	4.35	8.15	0.80	.....	0	32.3	0.0443	0.00169	Trace.	8.90	2.99	Do.
	do.....	118	92	20.96	.000	.00	.13	12.15	4.42	10.00	1.06	.....	0	28.6	0.0443	0.00101	Trace.	8.90	9.16	Do.
	Mar. 31	104	63	28.30	.080	.00	.14	11.76	5.68	6.14	0.86	.....	0	39.6	0.0221	0.00271	Trace.	5.50	Trace.	Drilled well.
Shallow well. Mixture of water from the cores formed in the freezing of cakes of ice. Water with which the cans were filled: Filtered water from Miraflores purification plant.	Apr. 6	117	72	24.75	.120	.02	.40	11.15	5.86	5.87	0.52	.....	0	37.2	0.0000	0.00169	Trace.	6.50	0.52	Do.
	Apr. 25	1,902	1,402	31.60	1.500	Trace.	Trace.	280.8	85.52	100.3	9.41	.....	0	125.6	0.0000	0.00339	.00	750.00	62.90	Do.
	do.....	343	274	43.70	.230	Trace.	Trace.	63.35	23.78	19.7	2.90	.....	0	170.8	0.0443	0.00576	.00	15.50	1.44	Do.
Filtered water from can filler.	Mar. 17	92.8	.....	43.30	.100	Trace.	.22	7.15	3.05	6.00	2.13	.....	0	26.50	0.00	0.00339	Trace.	3.50	1.27	Mixture of water from the cores formed in the freezing of cakes of ice.
	May 19	684	490	110.70	.105	.....	.711	77.84	23.94	.....	.....	41.40	0	152.00	.....	.....	Trace.	108.0	80.87	Do.
	do.....	103	72	15.45	.033	.033	.38	10.86	3.67	5.22	0.945	.....	0	22.60	.....	.....	Trace.	10.5	10.78	Water with which the cans were filled: Filtered water from Miraflores purification plant.













## SECTION OF METEOROLOGY AND HYDROGRAPHY.

The section of meteorology and hydrography continued to keep the permanent records of weather conditions on the Canal Zone, the hydrology of Gatun Lake watershed, including the operation of the spillway, and the hydrographic conditions at the Atlantic and Pacific approaches to the canal and at the locks.

The rainfall for the year was generally above the normal over the Atlantic and northern half of the central section, and slightly deficient over the Pacific and southern half of the central section.

Special attention is invited to the report of the chief hydrographer, in which the statement is made that the yield of Gatun Lake watershed during the dry season months of 1916, January to April, inclusive, was normal, or an actual yield of 2,200 cubic feet per second, against an estimated yield of 2,160 cubic feet per second. It was necessary to waste, during January, over 2,000,000,000 cubic feet of water, but during February, March, and April the inflow was exceeded by water usage and evaporation. From January 1 to May 1 the lake was lowered 0.42 of a foot, representing a loss of 1.95 billion cubic feet of storage. The 2,000,000,000 cubic feet which were spilled after all regular demands for water had been met would have been sufficient to provide for approximately 330 lockages in addition to those actually made during the dry season.

The details of the work accomplished by this section are covered by the report of the chief hydrographer, which follows:

## SECTION OF METEOROLOGY AND HYDROGRAPHY.

*F. D. Willson, chief hydrographer.*

The personnel of the section has remained unchanged, with the exception that Mr. Geo. J. Bentley, meteorologist at Colon, was succeeded in April by Mr. Lester T. Chapel.

## METEOROLOGY.

Very few changes were made during the past fiscal year in the meteorological stations operated under the direction of the chief hydrographer. All of the stations enumerated in the annual report of The Panama Canal for the fiscal year 1914-15 were continued in operation except as noted below.

The tide gauge at Balboa was moved on September 19, 1915, from the old location under the Panama Railroad steel pier to the new concrete dock (No. 18).

Arrangements were made during the year whereby the weather conditions prevailing over the Caribbean Sea, the Gulf of Mexico, and the south Atlantic Ocean each day at 2 p. m. are received and distributed to the port captains and other shipping interests.

At the request of the Argentine Government, the daily weather conditions prevailing over the Canal Zone at 8 a. m. are cabled to Buenos Aires.

*Precipitation.*—The rainfall for the calendar year 1915 was above the average at 10 stations and deficient at 8 stations. The annual totals ranged from 152.77 inches at Colon to 65.37 inches at Balboa. The average precipitation over the Pacific section was 74.98 inches; 102.61 inches over the central section; and 148.60 inches over the Atlantic section.

March was the month of least rainfall, and although there were several local exceptions, October was in general the rainiest month.

The 1915 dry season rainfall over the Pacific section amounted to 10 per cent of the annual total, 14 per cent over the central section, and 20 per cent over the Atlantic section. This increase in the percentage of rainfall during the dry season was due to the two storms, or so-called "Northers," that deluged the Isthmus with rain during the periods from February 9 to 11 and from April 3 to 5.

The maximum 24-hour rainfall recorded during the year was 8.30 inches at Gatun on April 3 and 4. Daily quantities in excess of four inches were recorded as follows:

Station.	Date.	Inches.	Station.	Date.	Inches.
Colon.....	Feb. 10	7.12	Brazos Brook.....	Feb. 10	6.18
Do.....	Apr. 3	4.98	Do.....	Apr. 3	5.27
Do.....	July 1	6.30	Do.....	June 8	4.04
Do.....	Oct. 16	4.69	Gatun.....	Feb. 10	6.57
Gatun.....	Apr. 3	7.64	Monte Lirio.....	Apr. 3	5.40
Monte Lirio.....	Oct. 9	4.60	Trinidad.....	Feb. 10	4.60
Frijoles.....	Apr. 3	5.13	Vigia.....	May 20	4.21
Vigia.....	Oct. 31	4.64	Alhajuela.....	July 8	5.33
Empire.....	do.....	4.11	Comacho.....	Oct. 31	4.26
Rio Grande.....	do.....	4.31			

The rainfall during the first six months of 1916 has been above normal over the Pacific section and southern part of the central section, and below normal over the Atlantic section and northern part of the central section.

Monthly records for 1915, 1916, and the station averages, are presented in Table No. 1, while the maximum rainfall or record for periods of 5 minutes, 1 hour, and 24 hours, at stations equipped with automatic registers, is shown in Table No. 2.

*Temperature.*—The average air temperature for the year 1915 was near the normal on the Pacific coast, and approximately 1 degree Fahrenheit above the normal on the Atlantic. March was the month of highest mean temperature on both coasts, while July was the month of lowest mean temperature on the Atlantic coast, and November on the Pacific.

The means and extremes in air temperature for the year 1915 at the two first-class stations are given in the following table:

Station.	Maximum.		Minimum.		Annual mean ° F.
	° F.	Date.	° F.	Date.	
Balboa Heights.....	93	Apr. 11	69	Jan. 31	80.6
Colon.....	91	Sept. 27	72	Feb. 10	81.2

The absolute maximum and minimum temperatures for the years of record are shown below, revised to June 30, 1916:

Station.	Maximum.		Minimum.	
	° F.	Date.	° F.	Date.
Balboa Heights.....	97	Apr. 7, 1912	63	Jan. 27, 1910
Colon.....	92	June 3, 1909	66	Dec. 3, 1909

The lowest temperature of record on the Isthmus is 59° F., observed at Bas Obispo on February 9, 1907. The maximum temperature record of 97° F., at Balboa Heights (then Ancon), was equaled at the Naos Island station on February 13, 1906.

The temperature during the first six months of 1916 has been generally below normal on the Pacific coast and above normal on the Atlantic.

Monthly temperature records and other meteorological data for the year 1915 at the two first-class stations are presented in Tables Nos. 3 and 4.

*Wind.*—The wind movement over the Canal Zone for the year 1915 was slightly below the average. Northerly winds prevailed. On the Atlantic coast February was the month of greatest wind movement and June the month of least movement, while over the interior and Pacific coast the greatest movement occurred in March, and, in general, November was the month of least movement.

The following table revised to June 30, 1916, shows the maximum wind velocities of record at the first-class stations:

Station.	Maximum velocity.		Date.
	Miles per hour.	Direction.	
Balboa Heights.....	59	S.	July 10, 1909
Colon.....	46	N.	Apr. 4, 1915

*Atmospheric pressure.*—The mean atmospheric pressure for the year 1915 was slightly below the normal. On the Atlantic coast the highest mean pressure occurred in March and December and the lowest in May, while on the Pacific coast the month of maximum pressure was November and of minimum pressure June.

*Relative humidity.*—The mean relative humidity of the atmosphere for the year 1915 was slightly above the average at both coast stations. On the Atlantic coast August was the month of highest average humidity and January the month of lowest average humidity, while on the Pacific coast the months of highest and lowest average humidity were, respectively, November and March.

*Cloudiness.*—The average daytime cloudiness for the year 1915 was slightly above normal on both coasts. July was the month of heaviest cloudiness, while the least average cloudiness occurred in January.

*Evaporation.*—The evaporation during the year 1915 was above the average on both coasts, but below the normal over Gatun Lake surface, the yearly total being the lowest on record. Evaporation during the first six months of 1916 has also been above the average on both coasts, while over Gatun Lake surface the deficiency has been well marked.

The monthly records are given in Table No. 5. The total evaporation for the year 1915, together with the station averages, are presented in the following table:

Station.	Evaporation, inches.		Years of record.
	1915	Average.	
Balboa Heights.....	55.911	50.421	8
Gatun.....	59.932	62.637	5
Colon.....	52.226	51.015	7½

*Fogs.*—No fogs were observed during the year 1915 at the Atlantic coast station, while a total of three fogs were observed at the Balboa Heights station near the Pacific coast. Numerous fogs were observed at interior stations where fog records are kept, and practically all observed lifted or were dissipated by 8.30 a. m.

*Sea temperature.*—The surface temperature of the sea was approximately 1° F. above normal on both coasts. The means and extremes for the year 1915 are given in the following table:

Station.	Maximum.		Minimum.		Annual mean.
	° F.	Date.	° F.	Date.	
Balboa.....	90	Nov. 27	71	Apr. 16	81.4
Colon.....	88	May 18	79	Feb. 11	83.5

<sup>1</sup> On other dates also.

*Tidal conditions.*—Tide registers were continued in operation at Balboa and Colon. The tidal extremes for the years of record at these stations are given below (length of record, eight years)—table revised to June 30, 1916:

Station.	Maximum high water.		Extreme low water.		Maximum daily range. <sup>1</sup>		Minimum daily range. <sup>1</sup>	
	Elevation.	Date.	Elevation.	Date.	Feet.	Date.	Feet.	Date.
Balboa....	-11.2	Oct. 2, 1909	-10.6	Apr. 11, 1910	20.8	Apr. 11, 1910	4.9	Feb. 24, 1915
Colon.....	1.68	Feb. 11, 1915	1.01	June 9, 1910	2.17	Feb. 28, 1911	.....	( <sup>2</sup> )

<sup>1</sup> For consecutive tides.<sup>2</sup> One tidal fluctuation often entirely absent at Colon.

*Seismology.*—Fifty-nine seismic tremors were recorded at the Balboa Heights seismological station during the fiscal year ending June 30, 1916. Six of these disturbances were of sufficient intensity to throw the pens from the instruments, and quite a number were strong enough to be generally felt in the Canal Zone. Most of the tremors were of comparatively local origin (less than 600 miles). There was an apparent revival of activity in the Los Santos Province that reached the maxima during the latter part of November, 1915, and during the first part of February, 1916. After this time the scene of activity shifted to the northwest, culminating in the tremors of April 26, during one of which considerable damage was done to the wharf and merchandise stocks of the United Fruit Co. at Bocas del Toro. The intensities of the various shocks varied from I to V on the Rossi Forel scale of I to X.

A complete list of seismic disturbances recorded at Balboa Heights during the fiscal year 1915-16 is given in Table No. 7.

The following tables accompany this report:

No. 1. Monthly rainfall on the Isthmus of Panama.

No. 2. Maximum rainfall in the Canal Zone.

No. 3. Monthly meteorological data, Balboa Heights, year 1915.

No. 4. Monthly meteorological data, Colon, year 1915.

No. 5. Monthly evaporation, Canal Zone, 1915, 1916, and averages.

No. 6. Tidal conditions, year 1915.

No. 7. Seismograph records, Balboa Heights, fiscal year 1915-16.

TABLE NO. 1.—*Monthly rainfall on Isthmus of Panama, 1915-16, and station averages.*

[Value in inches.]

Stations.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Balboa:													
1915.....	2.23	2.73	0.00	4.37	7.92	2.37	6.66	13.09	3.59	10.29	7.64	4.48	65.37
1916.....	1.15	1.46	.43	3.06	12.64	3.95	.....	.....	.....	.....	.....	.....	.....
Average, 17 years	1.11	.65	.68	3.92	8.21	7.58	8.11	7.69	6.79	9.49	9.19	5.84	69.26
Balboa Heights:													
1915.....	2.12	2.96	T.	5.37	6.42	2.85	6.93	15.24	3.69	10.49	7.05	3.60	66.72
1916.....	1.41	1.48	.89	2.84	12.59	4.39	.....	.....	.....	.....	.....	.....	.....
Average, 18 years	1.02	.89	.67	2.87	8.67	7.81	7.72	7.89	7.58	10.53	10.27	4.40	70.32
Miraflores:													
1915.....	1.67	1.17	.07	2.88	13.38	5.46	8.14	11.35	6.12	17.29	8.43	5.13	81.09
1916.....	2.19	.59	.20	8.27	11.10	5.62	.....	.....	.....	.....	.....	.....	.....
Average, 7 years.	1.85	1.47	.52	3.07	10.51	9.13	7.88	8.58	9.37	12.58	11.19	7.22	83.37
Pedro Miguel:													
1915.....	1.03	1.69	.22	2.39	10.24	7.69	8.59	10.41	6.78	16.38	7.92	3.62	76.96
1916.....	1.71	.86	.41	9.82	13.10	6.42	.....	.....	.....	.....	.....	.....	.....
Average, 8 years.	1.04	.90	.30	3.07	11.23	9.95	8.51	8.48	8.45	12.24	10.49	6.12	80.78
Rio Grande:													
1915.....	.57	2.81	.19	3.41	9.32	8.01	10.24	10.04	8.51	17.49	8.02	6.14	84.75
1916.....	.68	1.12	.83	5.23	11.22	8.67	.....	.....	.....	.....	.....	.....	.....
Average, 11 years	1.32	.81	.28	3.05	10.88	9.15	10.01	9.96	10.52	12.50	10.52	5.55	84.55
Culebra:													
1915.....	1.33	3.63	.09	3.81	7.28	10.03	12.99	9.96	9.21	14.78	12.27	5.14	90.52
1916.....	1.30	1.61	.56	5.66	10.91	7.56	.....	.....	.....	.....	.....	.....	.....
Average, 25 years	1.67	.67	.63	3.55	11.11	8.88	9.33	10.48	10.69	11.33	12.10	7.24	87.68
Camacho:													
1915.....	.61	3.45	.88	4.52	7.56	6.06	12.06	8.70	10.70	17.64	11.93	4.51	88.62
1916.....	1.42	1.36	.62	4.02	10.93	7.12	.....	.....	.....	.....	.....	.....	.....
Average, 9 years.	1.09	1.01	.48	3.18	11.79	9.65	9.58	10.00	10.44	13.43	12.52	5.84	89.01
Empire:													
1915.....	.67	3.53	.24	4.96	8.56	7.11	12.17	9.92	8.21	16.36	10.60	4.67	87.00
1916.....	1.07	1.49	.84	4.05	9.92	7.03	.....	.....	.....	.....	.....	.....	.....
Average, 11 years	.78	.84	.35	3.17	10.02	8.49	8.78	9.81	8.48	13.19	10.79	5.11	79.81
Gamboa:													
1915.....	1.74	2.75	.02	7.09	5.10	9.01	8.03	4.51	9.91	15.93	8.37	7.00	79.46
1916.....	2.16	1.52	.89	6.68	12.25	8.44	.....	.....	.....	.....	.....	.....	.....
Average, 33 years	1.77	.89	.76	3.51	10.85	9.86	10.12	11.97	10.48	12.68	12.06	6.79	91.74



TABLE No. 1.—*Monthly rainfall on Isthmus of Panama, 1915-16, and station averages—Continued.*

[Value in inches.]

Stations.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Juan Mina:													
1915.....	1.06	3.43	.20	7.74	6.91	15.11	13.50	9.39	9.02	19.23	12.49	7.42	105.53
1916.....	1.46	2.56	.88	8.12	9.46	6.91							
Average, 5 years.....	.54	1.41	.17	2.54	11.05	11.82	9.73	11.18	11.43	14.10	12.45	5.20	91.62
Alhajuela:													
1915.....	.86	2.53	.04	8.94	8.20	8.09	15.71	10.39	9.60	16.61	11.93	5.87	98.77
1916.....	.66	1.34	.37	5.84	12.40	14.00							
Average, 16 years.....	1.12	.83	.55	3.32	11.97	12.46	12.65	12.75	11.64	13.84	14.44	6.40	101.97
Vigia:													
1915.....	.39	2.34	.46	6.77	10.88	12.48	17.74	12.16	10.37	18.50	12.42	3.44	107.55
1916.....	.22	1.33	.42	8.17	12.41	13.53							
Average, 7 years.....	.90	2.12	.53	2.60	11.59	13.74	12.04	12.74	12.48	16.23	15.29	5.32	105.58
Frijoles:													
1915.....	3.63	5.66	.69	11.56	10.71	10.54	20.10	7.62	9.84	16.19	19.67	6.68	122.89
1916.....	1.32	3.48	2.01	3.55	8.45	8.02							
Average, 4 years.....	2.24	3.26	.37	4.54	14.10	11.39	10.14	11.42	10.98	17.22	15.55	6.00	107.21
Trinidad:													
1915.....	2.46	8.88	1.15	9.27	8.51	13.01	13.61	8.38	10.14	11.41	11.65	8.42	106.89
1916.....	2.03	2.81	2.77	4.93	12.09	7.50							
Average, 8 years.....	3.01	3.26	2.35	5.12	13.78	11.16	9.00	10.39	12.18	14.50	18.33	9.28	112.36
Monte Lirio:													
1915.....	2.54	6.57	.76	12.19	11.17	10.40	15.73	12.47	14.87	17.78	24.27	10.16	138.91
1916.....	.75	2.60	2.66	4.73	8.41	11.81							
Average, 8 years.....	3.12	4.05	2.67	5.57	13.82	12.87	12.33	11.93	13.12	16.73	21.99	9.88	128.08
Gatun:													
1915.....	1.80	13.17	.90	15.90	10.24	12.66	18.21	12.31	16.12	19.55	18.28	7.23	146.37
1916.....	1.05	2.13	3.25	4.72	11.32	10.60							
Average, 11 years.....	3.52	3.31	2.38	5.18	14.87	13.23	11.98	14.46	10.43	16.53	20.54	11.54	127.97
Brazos Brook:													
1915.....	2.96	14.32	.96	12.17	6.41	16.48	21.24	11.48	14.51	18.32	18.96	8.84	146.65
1916.....	1.50	3.62	2.75	4.99	14.23	13.21							
Average, 9 years.....	3.41	3.70	2.48	4.86	13.05	15.54	16.12	14.59	12.07	16.48	22.97	12.58	137.85
Colon:													
1915.....	3.41	12.37	1.71	10.42	7.75	16.01	20.72	12.89	13.85	21.86	22.33	9.45	152.77
1916.....	2.33	1.96	2.68	6.25	9.38	14.28							
Average, 45 years.....	3.95	1.72	1.63	4.19	12.66	13.44	16.32	15.05	12.55	14.72	21.68	12.04	129.95

NOTE.—Station averages do not include records for the year 1916.

TABLE No. 2.—*Maximum rainfall in Canal Zone, Oct. 1, 1905, to June 30, 1916.*

[Value in inches.]

Stations.	Maximum rainfall.					
	5 minutes.		1 hour.		24 hours. <sup>1</sup>	
	Inches.	Date.	Inches.	Date.	Inches.	Date.
Balboa (June 10, 1906).....	0.90	May 12, 1912	5.86	June 2, 1906	7.57	Nov. 16-17, 1906.
Balboa Heights (Oct. 1, 1905) <sup>2</sup> .....	.64	Aug. 7, 1908	3.98	Oct. 9, 1911	7.23	May 12-13, 1912.
Miraflores (Jan. 19, 1914).....	.45	Jan. 5, 1915	2.37	Oct. 9, 1915	4.70	Nov. 11, 1912. <sup>3</sup>
Pedro Miguel (Jan. 1, 1908).....	.60	Nov. 11, 1908	3.30	Aug. 27, 1908	4.64	May 25-26, 1914.
Rio Grande (Dec. 29, 1905).....	.75	July 24, 1908	3.10	Sept. 21, 1912	6.00	Dec. 2-3, 1906.
Culebra (July 1, 1906) <sup>4</sup> .....	.64	May 2, 1908	3.69	Oct. 16, 1907	5.55	Dec. 3, 1906. <sup>5</sup>
Empire (July 18, 1906).....	.60	July 25, 1906	3.63	Oct. 1, 1909	6.15	Do. <sup>5</sup>
Gamboa (Nov. 18, 1905).....	.59	July 27, 1908	3.32	May 11, 1911	6.56	Dec. 2-3, 1906.
Alhajuela (Mar. 31, 1907).....	.60	July 20, 1909	4.19	July 8, 1915	8.19	Do. <sup>5</sup>
Frijoles (June 26, 1913).....	.54	July 23, 1915	2.81	July 21, 1915	6.73	Apr. 3-4, 1915.
Gatun (Aug. 24, 1907).....	.62	{Aug. 3, 1912 Aug. 12, 1914}	4.72	Aug. 12, 1914	10.48	Dec. 3, 1906. <sup>5</sup>
Colon (Oct. 1, 1905).....	.64	Aug. 25, 1909	4.90	Oct. 8, 1909	8.53	Dec. 2-3, 1906.
Porto Bello (May 1, 1908) <sup>6</sup> .....	7.24	Nov. 29, 1911	4.53	Nov. 29, 1911	10.86	Dec. 28-29, 1909.
Bohio (Oct. 1, 1905) <sup>8</sup> .....	.67	June 16, 1909	4.51	Aug. 7, 1908	8.85	Aug. 7-8, 1908.

<sup>1</sup> Maximum fall in any 24 consecutive hours.<sup>2</sup> Formerly Ancon. Station moved to Balboa Heights Oct. 1, 1914.<sup>3</sup> From standard gauge reading.<sup>4</sup> Automatic gauge discontinued June 28, 1915.<sup>5</sup> No automatic record on this date, total for 24 hours ending at noon.<sup>6</sup> Automatic gauge discontinued May 9, 1914—station closed Aug. 31, 1914.<sup>7</sup> Approximate: Automatic record indistinct, due to unusually excessive rate of fall.<sup>8</sup> Station closed January, 1912.

NOTE.—Dates in parenthesis opposite station names refer to installation of automatic register.

TABLE NO. 3.—*Monthly meteorological data, year 1915, Balboa Heights, Canal Zone.*<sup>1</sup>

Month.	Atmospheric pressure (inches).		Air temperature (°F.).								Maximum daily range.	Mean wet thermometer.	Mean temperature dew point.	Mean relative humidity.
	Station. <sup>2</sup>	Sea level.	Monthly mean.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.					
January.....	29.706	29.828	81.5	91	20	89.4	69	31	73.6	20	74	74	88	
February.....	29.716	29.838	81.3	92	5	89.0	70	1	73.6	20	74	73	86	
March.....	29.720	29.842	83.0	93	19	90.7	71	9	75.3	19	75	73	82	
April.....	29.724	29.846	80.5	93	11	87.0	71	30	74.0	18	75	73	84	
May.....	29.683	29.804	81.2	93	3	87.1	72	26	75.4	19	77	76	89	
June.....	29.698	29.819	81.0	92	19	86.6	74	11	75.5	18	77	76	90	
July.....	29.714	29.836	79.8	90	29	85.4	70	17	74.3	15	76	76	92	
August.....	29.708	29.828	80.4	91	12	86.4	72	9	74.5	17	76	76	93	
September.....	29.704	29.825	80.2	91	24	86.1	72	16	74.4	15	76	75	90	
October.....	29.706	29.828	79.1	89	15	84.2	72	25	74.0	15	75	75	92	
November.....	29.730	29.852	78.8	87	17	84.4	70	11	73.1	17	75	74	94	
December.....	29.727	29.849	80.1	90	30	87.1	70	8	73.1	18	75	74	91	
Year.....	29.711	29.833	80.6	93	<sup>3</sup> 11	87.0	69	<sup>4</sup> 31	74.2	20	75.4	74.6	89.2	

Month.	Precipitation (inches).			Wind.					Number of days.				
	Monthly total.	Normal <sup>5</sup>	Rainy days.	Total movement (miles).	Prevailing direction.	Maximum velocity.			Clear.	Partly cloudy.	Cloudy.	Thunderstorms.	Average cloudiness. <sup>6</sup>
						Miles per hour.	Direction.	Date.					
January.....	2.12	1.02	6	4,024	N.	29	N.	13	12	15	4	0	4.3
February.....	2.96	0.89	11	5,921	N.	31	N.	26	1	20	7	0	6.1
March.....	5.37	0.67	0	7,086	N.	29	N.	3	0	23	8	0	6.3
April.....	5.37	2.87	10	6,724	N.	39	N.	5	1	18	11	3	7.0
May.....	6.42	8.67	19	5,096	N.	47	SW.	26	0	17	14	7	6.9
June.....	2.83	7.81	18	4,617	NW.	25	S.	5	0	8	22	11	8.3
July.....	6.93	7.72	22	4,375	NW.	33	NW.	28	0	0	31	16	9.2
August.....	15.24	7.89	22	4,576	NW.	35	NE.	3	0	4	27	19	8.9
September.....	3.69	7.58	15	4,841	N.	32	SW.	26	0	8	22	15	8.4
October.....	10.49	10.53	25	4,695	NW.	35	NW.	23	0	0	31	10	9.4
November.....	7.05	10.27	24	3,966	NW.	24	NE.	17	0	2	28	12	9.1
December.....	3.60	4.40	15	5,328	NW.	24	NW.	22	0	16	15	7	7.6
Year.....	66.72	70.32	187	64,249	N.	47	SW.	726	14	131	220	100	7.5

<sup>1</sup> Station formerly Ancon; moved to Balboa Heights Oct. 1, 1914.<sup>2</sup> Elevation of barometer 118 feet above sea level.<sup>3</sup> April.<sup>4</sup> January.<sup>5</sup> Average for 18 years' record.<sup>6</sup> Tenths of sky.<sup>7</sup> May.

TABLE NO. 4.—*Monthly meteorological data, year 1915, Colon, Republic of Panama.*

Month.	Atmospheric pressure (inches).		Air temperature (°F.).							Maximum daily range.	Mean wet thermometer.	Mean temperature dew point.	Mean relative humidity.
	Station. <sup>1</sup>	Sea level.	Monthly mean.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.				
January.....	29.816	29.842	81.8	87	6	85.5	74	28	78.0	12	77	75	84
February.....	29.824	29.850	81.4	87	17	85.3	72	10	77.4	14	77	75	85
March.....	29.834	29.860	82.6	89	5	86.0	76	18	79.2	10	78	76	86
April.....	29.829	29.855	81.5	89	26	85.5	74	28	77.5	14	77	75	85
May.....	29.780	29.806	82.0	89	6	86.1	74	27	77.9	13	78	77	88
June.....	29.794	29.820	81.2	89	16	85.5	75	8	77.0	12	78	77	89
July.....	29.803	29.829	80.2	89	20	84.1	72	1	76.2	12	78	77	92
August.....	29.807	29.833	80.6	90	14	84.4	74	9	76.8	12	78	78	94
September.....	29.800	29.826	81.4	91	27	86.5	72	22	76.2	15	78	77	90
October.....	29.800	29.826	80.8	90	26	86.2	74	16	75.5	15	77	76	90
November.....	29.828	29.854	80.4	89	3	85.7	74	27	75.2	15	76	75	90
December.....	29.834	29.860	80.8	87	21	85.3	73	3	76.4	13	77	75	86
Year.....	29.812	29.838	81.2	91	<sup>2</sup> 27	85.5	72	<sup>3</sup> 10	76.9	15	77.2	76.1	88.2

Month.	Precipitation (inches).			Wind.					Number of days.				
	Monthly total.	Normal. <sup>4</sup>	Rainy days.	Total movement (miles).	Prevailing direction.	Maximum velocity.			Clear.	Partly cloudy.	Cloudy.	Thunderstorms.	Average cloudiness. <sup>6</sup>
						Miles per hour.	Direction.	Date.					
January.....	3.41	3.95	16	9,494	N.	30	N.E.	10	14	13	4	0	4.4
February.....	12.37	1.72	15	10,278	N.	39	N.	9	11	14	3	0	4.6
March.....	1.71	1.63	12	10,492	N.	32	N.E.	24	4	20	7	0	5.5
April.....	10.42	4.19	18	9,477	N.	46	N.	4	8	15	7	6	5.4
May.....	7.75	12.66	20	6,404	S.E.	23	SW.	15	3	14	14	14	7.3
June.....	16.01	13.44	25	5,205	S.E.	27	S.	6	0	9	21	17	7.9
July.....	20.72	16.32	29	5,590	W.	26	W.	1	0	0	31	15	9.3
August.....	12.89	15.05	24	5,551	W.	26	W.	10	0	11	20	18	7.9
September.....	13.85	12.55	20	5,447	S.E.	32	S.	27	1	17	12	22	7.0
October.....	21.86	14.72	29	5,436	S.E.	30	SW.	31	0	11	20	20	7.9
November.....	22.33	21.68	27	5,354	S.E.	30	N.E.	9	1	8	21	16	7.9
December.....	9.45	12.04	18	8,382	N.	31	N.E.	31	11	11	9	5	5.6
Year.....	152.77	129.95	253	87,110	N.	46	N.	<sup>5</sup> 4	53	143	169	133	6.7

<sup>1</sup> Elevation of barometer 25 feet above sea level.<sup>2</sup> September.<sup>3</sup> February.<sup>4</sup> Average for 45 years of record.<sup>5</sup> April.<sup>6</sup> Tenths of sky.

TABLE No. 5.—*Monthly evaporation, Canal Zone, years 1915 and 1916.*

[Value in inches.]

Month.	Balboa Heights. <sup>1</sup>			Gatun.			Colon.		
	1915	1916	Average (8 years).	1915	1916	Average (5 years).	1915	1916	Average (7½ years).
January.....	7.588	6.516	5.611	6.398	6.280	6.028	6.770	6.840	6.111
February.....	6.149	6.828	5.940	5.430	5.985	6.130	5.889	6.080	6.047
March.....	8.742	7.030	7.183	6.698	6.424	7.375	6.322	6.280	7.055
April.....	6.044	5.142	5.350	5.781	6.391	6.171	5.340	5.185	6.028
May.....	3.986	3.183	3.479	5.361	5.290	5.171	5.136	3.781	3.870
June.....	3.760	2.448	3.024	5.040	4.430	4.149	3.911	3.734	3.152
July.....	2.701	.....	3.256	4.107	.....	4.548	2.332	.....	3.031
August.....	3.288	.....	3.233	4.354	.....	4.466	3.203	.....	3.197
September.....	3.453	.....	3.231	4.315	.....	4.341	3.022	.....	3.240
October.....	2.725	.....	3.352	3.623	.....	4.086	3.034	.....	3.353
November.....	2.826	.....	2.957	3.564	.....	3.467	2.695	.....	2.939
December.....	4.644	.....	4.221	4.656	.....	4.843	4.572	.....	4.234
Year.....	55.911	.....	50.421	59.932	.....	62.637	52.226	.....	51.015

<sup>1</sup> Formerly Ancon. Station moved to Balboa Heights Oct. 1, 1914.

NOTE.—Insulated tanks 10 inches in diameter at Balboa Heights and Colon. Water surface protected from action of sun and rain. Exposed pan 4 feet in diameter and 10 inches deep floating in water at Gatun. For monthly evaporation during past years, see previous annual reports.

TABLE No. 6.—*Tidal conditions, year 1915.*

[Elevations in feet referred to mean sea level.]

## PACIFIC COAST—BALBOA, CANAL ZONE.

Month.	Maximum high.	Date.	Extreme low.	Date.	Maximum ampli- tude. <sup>1</sup>	Date.	Minimum ampli- tude. <sup>1</sup>	Date.
January.....	8.5	18	—8.8	17	17.2	17	5.6	25
February.....	8.5	3	—8.9	15	16.9	15	4.9	24
March.....	9.4	4	—9.2	31	18.4	5	5.4	25
April.....	10.2	2	—9.8	30	19.6	2	6.6	23
May.....	9.6	1	—9.6	1	19.2	1	8.4	22
June.....	9.1	28	—8.5	28	17.6	28	8.3	7
July.....	8.7	28 and 29	—8.8	27	17.5	28	7.0	7
August.....	9.0	27	—8.4	25	17.2	26	6.5	7
September.....	9.3	25	—8.6	13	17.4	12	5.3	4
October.....	9.9	10 and 11	—8.9	11	18.8	11	5.8	3
November.....	9.7	9	—9.2	9	18.9	9	6.2	1
December.....	9.2	8 and 9	—9.3	9	18.5	9	7.7	1
Year.....	10.2	Apr. 2	—9.8	Apr. 30	19.6	Apr. 2	4.9	Feb. 24

## ATLANTIC COAST—COLON, REPUBLIC OF PANAMA.

January.....	1.52	16	—0.38	28	1.73	13	0.21	9
February.....	1.68	11	— .24	3 and 8	1.59	8 and 9	.20	4
March.....	1.20	27	— .51	9	1.61	9	.21	24
April.....	1.52	7	— .48	29	1.66	4	.22	26
May.....	1.23	29	— .72	2 and 31	1.91	29	.21	26
June.....	1.42	26	— .76	1	1.84	28	.20	21
July.....	1.38	23 and 24	— .51	10	1.80	24	.21	16
August.....	1.25	20	— .44	16 and 19	1.60	20	.21	4
September.....	1.32	18	— .40	2	1.48	18	.24	13 and 24
October.....	1.26	14	— .47	14	1.73	14	.23	6 and 20
November.....	1.29	7 and 8	— .50	9	1.71	8	.20	29
December.....	1.47	7	— .53	23	1.75	7	.23	13
Year.....	1.68	Feb. 11	— .76	June 1	1.91	May 29	.20	Feb. 4 <sup>2</sup>

<sup>1</sup> For consecutive tides.<sup>2</sup> And other dates.

NOTE.—One tidal fluctuation is often entirely absent at Colon.

TABLE No. 7.—*Seismograph records, Balboa Heights, Canal Zone, year ended June 30, 1916.*

[Lat. 8° 58' N.; Long. 79° 33' W.]

(100 K Bosch-Omori seismographs, Greenwich mean time, midnight to midnight.)

Date.	Component.	Time of beginning.		Time of—		Maximum amplitude, millimeters.	Approximate distance of epicenter.	
		Preliminary tremors.	Long waves.	Maximum.	End.		Miles.	Probable direction.
1915.								
July 14.	N.-S.	10 57 05	10 57 45	10 57 52	11 01 50	1.5	204	SW.
	E.-W.	10 57 08	10 57 56	10 58 05	11 01 45	1.2	240	SW.
Aug. 31.	N.-S.	21 33 40	21 35 00	21 36 00	21 36 25	.3	385	(?)
	E.-W.	21 33 40	21 35 00	21 35 35	21 36 25	.2	385	(?)
Sept. 7.	N.-S.	1 23 26	1 26 58	1 27 52	2 24 18	31.5	728	NW.
	E.-W.	1 23 19	1 26 59	1 23 33	2 23 16	23.0	755	NW.
Sept. 17.	N.-S.	6 14 10	6 14 46	6 15 00	6 16 30	.2	186	SW.
	E.-W.	6 14 10	6 14 46	6 14 50	6 16 30	.2	186	SW.
Sept. 20.	N.-S.	1 09 38	1 10 06	1 10 11	1 11 38	.8	150	(?)
	E.-W.	1 09 38	1 10 06	1 10 10	1 11 20	.5	150	(?)
Sept. 23.	N.-S.	7 54 52	7 55 10	7 55 14	7 56 40	3.0	105	SW.
	E.-W.	7 54 46	7 55 04	7 55 04	7 56 35	2.0	105	SW.
Oct. 11.	N.-S.	19 36 00	19 40 00	19 36 08	19 51 40	1.0	832	(?)
	E.-W.	19 35 55	19 40 00	19 36 10	19 56 25	1.0	832	(?)
Oct. 21.	N.-S.	2 25 12	2 25 40	2 25 45	2 29 55	1.5	150	SW.
	E.-W.	2 25 12	2 25 40	2 25 44	2 28 34	1.0	150	SW.
Nov. 26.	N.-S.	19 12 45	19 13 06	Pens off.	19 31 05	+58.0	118	SW.
	E.-W.	19 12 30	19 12 51	Pens off.	19 29 36	+55.0	118	SW.
Nov. 26.	N.-S.	19 34 33	19 34 55	19 34 58	19 36 30	1.0	123	SW.
	E.-W.	19 34 04	19 34 26	19 34 31	19 35 50	.5	123	SW.
Nov. 26.	N.-S.	20 23 36	20 23 58	20 24 04	(?)	10.0	123	SW.
	E.-W.	20 23 06	20 23 28	20 23 30	(?)	12.5	123	SW.
Nov. 26.	N.-S.	20 26 38	20 27 00	20 27 10	20 34 51	3.0	123	SW.
	E.-W.	(?)	20 26 30	20 26 38	20 32 15	4.0	(?)	SW.
Nov. 27.	N.-S.	0 14 36	0 14 58	0 15 04	0 16 27	.5	114	SW.
	E.-W.	0 14 18	0 14 36	0 14 39	0 16 34	.8	114	SW.
Nov. 27.	N.-S.	4 17 10	4 17 50	4 17 52	4 22 28	1.5	204	SW.
	E.-W.	4 16 44	4 17 24	4 17 28	4 20 20	2.0	204	SW.
Nov. 27.	N.-S.	19 04 19	19 04 43	19 04 49	19 07 15	1.2	132	SW.
	E.-W.	19 04 00	19 04 24	19 04 26	19 06 30	2.0	132	SW.
Nov. 27.	N.-S.	23 19 48	23 20 12	23 20 18	23 21 45	1.0	132	SW.
	E.-W.	23 19 20	23 19 44	23 19 46	23 21 16	1.0	132	SW.
Nov. 27.	N.-S.	23 22 12	23 23 36	23 23 40	23 24 30	.2	132	SW.
	E.-W.	23 22 46	23 23 10	23 23 14	23 24 20	.2	132	SW.
Nov. 30.	N.-S.	4 49 57	4 50 33	4 50 44	5 02 40	16.0	222	SW.
	E.-W.	4 49 32	4 50 20	4 51 00	5 01 40	9.0	222	SW.
Dec. 5.	N.-S.	1 24 00	1 24 26	1 24 34	1 26 30	2.0	141	SW.
	E.-W.	1 23 45	1 24 11	1 24 17	1 26 00	1.5	141	SW.
Dec. 12.	N.-S.	21 06 00	21 10 50	21 11 10	21 28 45	1.0	1,016	NW.
	E.-W.	21 06 00	21 11 00	21 08 30	21 22 30	.6	1,030	NW.
Dec. 15.	N.-S.	14 19 05	14 19 31	14 19 45	14 26 00	7.5	141	SW.
	E.-W.	14 19 05	14 19 31	14 19 34	14 26 00	11.0	141	SW.
Dec. 15.	N.-S.	19 22 12	19 22 36	19 22 38	19 28 00	8.0	132	SW.
	E.-W.	Record of movement lost—clock stopped.				14.0		
Dec. 26.	N.-S.	(?)	23 21 17	23 21 41	(?)	.2	(?)	(?)
	E.-W.	(?)	23 21 17	23 21 35	(?)	.2	(?)	(?)
Dec. 28 and 29.	N.-S.	23 44 25	23 49 00	23 50 07	0 06 20	1.0	950	NW.
	E.-W.	23 44 21	23 48 53	23 49 25	0 03 40	.8	950	NW.
Dec. 30.	N.-S.	6 45 33	6 46 50	6 47 00	6 55 20	.5	400	NW.
	E.-W.	6 45 34	6 46 55	6 47 15	6 54 10	.5	400	NW.
1916.								
Jan. 1.	N.-S.	At work on instrument at time of disturbance.						
	E.-W.	(?)	14 20 10	14 24 30	15 02 40	1.5	(?)	(?)
Jan. 13.	N.-S.	8 40 49	9 02 41	9 34 31	10 32 00	.7	4,500	(?)
	E.-W.	8 40 44	(?)	9 34 30	(?)	.5	(?)	(?)
Jan. 17.	N.-S.	12 29 12	12 30 15	12 30 18	12 35 22	2.5	300	(?)
	E.-W.	12 29 18	12 30 17	12 31 26	12 35 34	3.0	300	(?)
Jan. 24.	N.-S.	19 48 35	19 49 19	19 49 27	19 51 50	.8	220	(?)
	E.-W.	19 48 35	19 49 19	19 49 29	19 52 00	.5	220	(?)
Jan. 31.	N.-S.	18 05 36	18 20 26	18 23 26	18 44 00	1.5	3,000	(?)
	E.-W.	18 05 30	18 19 30	18 21 40	18 41 00	.5	3,000	(?)
Feb. 3.	N.-S.	9 04 13	(?)	(?)	(?)	.1	(?)	(?)
	E.-W.	9 04 20	(?)	(?)	(?)	.1	(?)	(?)
Feb. 8.	N.-S.	15 55 39	15 56 03	15 56 08	16 09 05	+106.0	130	SW.
	E.-W.	15 55 46	15 56 09	15 56 14	16 09 42	+103.0	130	SW.
Feb. 8.	N.-S.	16 10 46	16 11 01	16 11 25	(?)	.2	130	SW.
	E.-W.	16 10 46	16 11 01	16 11 25	(?)	.2	130	SW.
Feb. 8.	N.-S.	17 57 45	17 58 11	17 58 28	18 04 40	2.0	130	SW.
	E.-W.	17 57 32	17 57 56	17 57 59	18 05 42	6.0	130	SW.

TABLE NO. 7.—*Seismograph records, Balboa Heights, Canal Zone, year ended June 30, 1916—Continued.*

[Lat. 8° 58' N.; Long. 79° 33' W.]

Date.	Component.	Time of beginning.		Time of—		Maximum amplitude, millimeters.	Approximate distance of epicenter.	
		Preliminary tremors.	Long waves.	Maximum.	End.		Miles.	Probable direction.
1916.								
Feb. 8.....	N.-S.	18 13 00	(?)	(?)	(?)	Trace.	(?)	(?)
	E.-W.	18 13 00	(?)	(?)	(?)	Trace.	(?)	(?)
Feb. 9.....	N.-S.	2 45 12	2 45 40	2 45 44	2 49 07	2.0	130	SW.
	E.-W.	2 45 04	2 45 39	2 45 42	2 49 16	2.0	130	SW.
Feb. 9.....	N.-S.	10 33 00	(?)	(?)	(?)	Trace.	(?)	(?)
	E.-W.	10 33 00	(?)	(?)	(?)	Trace.	(?)	(?)
Feb. 27.....	N.-S.	20 23 15	20 24 58	Pens off.	21 30 00	+44.0	537	NE.
	E.-W.	20 23 16	20 25 04	Pens off.	21 06 00	+58.0	537	NE.
Mar. 1.....	N.-S.	19 50 16	(?)	(?)	19 57 00	.5	(?)	(?)
	E.-W.	19 50 22	(?)	(?)	19 56 00	.5	(?)	(?)
Mar. 21.....	N.-S.	19 56 56	19 57 44	19 57 50	19 59 58	.3	247	(?)
	E.-W.	19 56 58	19 57 44	19 57 56	19 59 46	.4	247	(?)
Mar. 27.....	N.-S.	13 43 38	13 43 40	13 43 46	13 44 14	1.8	32	SW.
	E.-W.							
Mar. 29.....	N.-S.	10 08 56	10 09 05	10 09 06	10 11 28	21.8	64	SW.
	E.-W.	10 09 00	10 09 09	10 09 10	10 10 50	16.0	64	SW.
Apr. 12.....	N.-S.	18 45 23	18 46 52	18 47 07	18 49 56	.5	425	NW.
	E.-W.	18 45 23	18 46 52	18 47 00	18 49 56	.5	425	NW.
Apr. 18.....	N.-S.	(?)	4 4 10	4 24 30	(?)	3.0	(?)	(?)
	E.-W.	(?)	4 4 14	4 24 26	(?)	.5	(?)	(?)
Apr. 24.....	N.-S.	4 30 00	4 32 28	4 32 50	4 38 20	2.0	600	NW.
	E.-W.	4 30 00	4 32 28	4 32 53	4 38 20	1.8	600	NW.
Apr. 24.....	N.-S.	Pen thrown off of recording drum.				+88.0	475	NW.
	E.-W.	8 02 30	8 04 10	8 04 30	8 36 00	56.0	475	NW.
Apr. 26.....	N.-S.	2 22 36	2 23 24	(1)	2 50 04	+72.0	249	NW.
	E.-W.	2 22 36	2 23 28	(1)	2 44 00	+75.0	249	NW.
Apr. 26.....	N.-S.	5 41 25	5 42 25	5 42 40	5 46 00	.8	294	NW.
	E.-W.	5 41 25	5 42 25	5 42 57	5 45 50	.5	294	NW.
Apr. 26.....	N.-S.	6 26 43	6 27 51	6 28 25	6 40 20	6.0	322	NW.
	E.-W.	6 26 43	6 27 47	6 28 12	6 40 00	3.5	322	NW.
Apr. 26.....	N.-S.	7 17 20	7 18 44	7 19 28	7 35 00	17.0	412	NW.
	E.-W.	7 17 20	7 18 48	7 20 44	7 34 10	16.0	412	NW.
Apr. 26.....	N.-S.	12 41 56	12 42 56	12 43 35	12 51 55	4.0	304	NW.
	E.-W.	12 41 56	12 43 00	12 43 50	12 51 55	3.0	304	NW.
May 3.....	N.-S.	No record—clock stopped—earthquake and blast record combined.						
	E.-W.	17 20 55	17 21 55	17 22 00	17 26 30	1.2	300	NW.
May 10.....	N.-S.	21 37 20	21 38 06	(1)	22 00 00	+87.0	240	NW.
	E.-W.	21 37 17	21 38 05	(1)	21 54 10	+85.0	240	NW.
May 13.....	N.-S.	7 38 35	7 39 11	7 39 20	7 42 10	.5	185	NW.
	E.-W.	7 38 35	7 39 11	7 39 19	7 40 30	Trace.	185	NW.
May 14.....	N.-S.	0 07 50	0 08 54	0 09 10	0 17 30	2.4	315	NW.
	E.-W.	0 07 55	0 09 00	0 09 20	0 17 25	1.5	315	NW.
June 19.....	N.-S.	1 18 48	1 23 28	1 24 12	1 38 30	3.0	960	N.
	E.-W.	Very slight record—too small to measure.				Trace.	(?)	N.
June 21.....	N.-S.	21 38 52	21 44 12	21 44 17	21 58 66	2.0	1,100	N.
	E.-W.	Very slight record—too small to measure.				Trace.	(?)	N.
June 27.....	N.-S.	18 56 36	18 58 04	18 58 04	19 03 00	2.0	420	NW.
	E.-W.	18 56 36	18 58 04	(?)	19 00 18	.5	420	NW.
June 30.....	N.-S.	3 01 48	3 04 16	3 04 38	3 23 26	6.0	600	NW.?
	E.-W.	3 01 48	3 04 00	3 05 32	3 23 12	5.0	600	NW.?

¹ Pen off.

NOTE.—Period of pendulum, 20 seconds; magnification, 35; damping medium. The amplitude indicates the maximum displacement of the pen. Laska's formula used in computing distances of remote earthquakes (620 miles or more) and Omori's formula for earthquakes less than 620 miles distant.

## HYDROGRAPHY.

The hydrographic features of the year were mostly of an operative character. The drainage on the lake for operative purposes during the year verified the predictions made from water-supply studies and also the adequacy of the spillways for controlling freshets.

Gatun Lake watershed practically yielded a normal amount of water during the dry-season months of 1916, January to April, inclusive. The total yield was 2 per cent in excess of the average 6-year period 1911 to 1916 (the period since the formation of Gatun Lake), or 2,200 cubic feet per second, against an estimated yield of 2,160 cubic feet per second.

In January, 1916, it was necessary to waste slightly over 2,000,000,000 cubic feet of water, but after January the inflow was exceeded by water usage and evaporation. The lake was lowered, from January 1 to May 1, 0.42 of a foot, with a loss of 1.95 billion cubic feet of storage. It is seen, therefore, that the yield was slightly over the dry-season needs if no water had been wasted by spilling. The number of lockages was low, owing to the canal being closed to commercial shipping up to April 15, 1916.

The 2,000,000,000 cubic feet which were spilled after all the regular demands for water had been met would have been sufficient to provide for approximately 330 lockages above those which actually were made during the period.

In 1916 the run-off from the section of Gatun Lake watershed above Alhajuela was 28 per cent below its average yield, or 1,002 cubic feet per second, against a 15-year dry-season normal of 1,387 cubic feet per second.

Tables 8 and 9 give the hydrology of Gatun Lake watershed for the year 1915 and the dry season of 1916. Likewise, Tables Nos. 10 and 11 cover Miraflores Lake watershed. Table No. 17 gives the monthly Gatun Lake, Miraflores Lake, and Chagres River heights for the year 1915. Table No. 14 gives the 1915 run-off data for the Chagres River above Alhajuela, and Table No. 15 gives like data for Gatun Lake watershed.

Plate No. 78 gives a graphical chart of the disposal of the total yield of Gatun Lake watershed for 1915 and dry season of 1916. Table No. 18 shows the relative disposition of the operative water losses during 1915. There were lockages as follows in 1915 and 1916:

	Calendar year 1915.	Dry season 1916.
Gatun.....	1,310	158
Pedro Miguel.....	1,305	220
Miraflores.....	1,319	163

Plate No. 80 shows the total yield, net yield, useful outflow, storage, yield from rainfall on the lake, and evaporation, massed, for the Gatun Lake watershed for the year 1915 and dry season of 1916. The net yield for 1915 was 122 per cent of the capacity of the lake at elevation +85, i. e., after allowing for evaporation the yearly inflow would have filled the lake over  $1\frac{1}{2}$  times to the operative level of +85. The following is the relative proportions of various sources of inflow and the uses put to the water produced in 1915:

	Per cent.
Total yield.....	100
Net yield.....	91
Land-area yield.....	81
Spillway waste.....	76
Yield from rain on lake surface.....	19
Operative or useful losses.....	15
Evaporation on lake.....	9

There were no large freshets during the year 1915, although the yield of the watershed was the largest in the 1911-15 period—the time Gatun Lake has been an actual body of water. Data on the principal freshets are given in Table No. 16, and Plate No. 77. Thirty-three well-distributed freshets during the year had a rise of over 5 feet at Vigia in 1915; the largest two were those of October 31 and November 15, 1915, with maximum discharges of 27,950 and 38,000 c. f. s., respectively, at Alhajuela. Eight freshets in the Chagres River exceeded 20,000 c. f. s. during the year. The following description of two distinct types of freshets is offered:

The freshet of November 15-16, 1915, was largely a Chagres River rise, there being practically no rainfall in the Canal Zone. The one on November 16-17, 1915, on the other hand, was mostly a Canal Zone freshet, most of the rainfall being from the Trinidad River basin.

The freshet of the 15th and 16th gave the highest momentary discharge from the Chagres River since November 28, 1912. There was a maximum discharge at Alhajuela of 38,000 c. f. s., and 12 and 18 hour average discharges of 23,650 and 18,450 c. f. s., respectively, covering the period from 2.30 p. m. on the 15th to 8.30 a. m. on the 16th.

Plate No. 77 covers rainfall and hydrographs of the principal stations for both freshets. It is noted that six spillway gates, with a maximum discharge of 66,330

c. f. s., were operated from 5.45 p. m. to 10.15 p. m. on the 15th, and five gates, with a maximum discharge of 55,815 c. f. s. were needed on the second freshet from 6 p. m. to 9.30 p. m. on the 16th. The following are the data on the two freshets:

Date.	(I). Alhajuela discharge.	(II). Gatun Spillway discharge + additional storage.	Per cent of (II) to (I).	Number (I) would have raised lake from—	Number (II) would have raised lake from—
Nov. 15-16...	1,195.56 million cubic feet.	2,731.15 million cubic feet.	228	85.50 to 85.76	85.50 to 86.10
Nov. 16-17...	447.98 million cubic feet.	1,830.00 million cubic feet.	409	85.50 to 85.60	85.50 to 85.90

A comparison of the maximum momentary discharges of the freshets of the Chagres River at Alhajuela since 1910 is as follows:

Date.	Vigia Heights.	Alhajuela Heights.	Alhajuela maximum discharge.	Rainfall, inches.		Remarks.
				Vigia.	Alhajuela.	
	<i>Feet.</i>	<i>Feet.</i>	<i>C. f. s.</i>			
Dec. 3, 1910.....	150.9	108.7	60,300	3.55	2.41	Maximum of 4 crests on Nov. 26, 27, 28, and 29.
Feb. 12, 1911.....	145.5	105.5	43,600	1.18	1.57	
Nov. 28, 1912.....	150.0	108.4	54,000	2.15	1.00	
Nov. 10, 1913.....	141.9	103.8	34,000	.....	.....	
Oct. 7, 1914.....	140.9	103.1	31,200	3.35	2.12	
Nov. 15-16, 1915...	142.7	104.3	38,000	3.40	3.03	

Sixty-three current meter measurements were made in the Chagres River at the Calle Larga gauging station above Alhajuela during 1915, and 28 in 1916 up to July 1, covering El. +112.50 to +96.3, inclusive. Eight gaugings were made in 1915, and five in 1916 at Dos Bocas (the forks of the Chagres and La Puente where it joins the Chagres), covering the discharges of the La Puente, the Pequeni, and the Chagres branches.

Alhajuela and Vigia have been continued as flood-warning stations.

*Currents in lower approach to Miraflores Locks.*—An investigation of the currents set up by the mixing of the fresh and salt water during the operation of the lock gates on the west side of the lower Miraflores Lock guide wall was made in September and October, 1915.

A Richie-Haskell direction-current meter was used in collecting the data. As the name implies, the instrument determines the direction and velocity of a current of running water, recording electrically on registers. In operation the meter is suspended from a boat at anchor by an armored cable, the core of which is made up of the necessary insulated wires forming the operating circuits. The velocity wheel is of the propeller type, and its mass is so concentrated as to make its moment of inertia a minimum. The make and break of the circuit for transmitting the number of revolutions of the wheel to the counting register in the boat is inside the meter. In the central chamber of the meter is a compass, its needle being free to assume the magnetic meridian. The chamber is filled with oil, and an expansion bag compensates for changes in temperature and pressure inside and outside the chamber. By use of an electric current, the azimuth of the water current, or axis of the meter, measured from the north point of the magnetic meridian, is transmitted to the direction register in the boat. The conditions under which the investigation was conducted were as follows:

Observations were taken with the direction-velocity current meter at 1, 10, 20, 30, and 40-foot depths below the water surface. The meter had been calibrated just previous to the commencement of the investigation and was in good working order.

A head of 20 feet above tide level was on in the lock chamber at each lockage just before the side wall valves were opened. After the equalization of the water the lower lock gates were opened and remained so from 10 to 20 minutes, when the lock gates were closed and the chamber refilled. It takes about three minutes to close



the lock gates, consequently there was some water leaving the lock chamber for 13 to 23 minutes. The longer interval of time was used for the sections farthest from the lock gates. The maximum surface velocities usually occurred from one to three minutes before it was developed at the lower depths. This is more pronounced as the distance from the lock gates increases.

Each feather on the current arrows represents the nearest three-tenths foot per second velocity actually recorded at that particular place and time, and is not claimed to be a constant argument in the investigation. The arrows float with the current. The figures below the arrows refer to the tide; those in parentheses refer to velocity in feet per second.

A whirlpool effect was observed at the 10 and 20 feet depths about section 3 between station two and the wing wall.

The observations taken are plotted separately on the five planes, in addition to which a time-velocity curve covering a complete lockage cycle from just previous to the opening of the valves until the gates are closed is shown on curve A of plate No. 74. This data covers velocities recorded at 1 and 40 feet depths. A simultaneous tide trace accompanies this curve. It will be noted that the tide is practically stationary during the 69 minutes consumed in this specific investigation, which was taken 50 feet south of the end of the crib protecting the center wall.

Observations taken on section 3 at station one at vertical intervals of 1 foot, beginning at 10 feet below the surface to a depth of 30 feet below the surface are shown with the tide trace taken just prior to the lockage on curve B, plate No. 74.

Attention is especially invited to the fact that the velocities here shown from the first vertical interval (the 10-foot depth) to the eighteenth interval do not harmonize with those shown on planes 1 and 2 at the same location, which were taken at a different time. This, however, is to be looked for in water flowing under the known conditions in this vicinity (the proximity of a whirlpool), as noted in a preceding paragraph.

The surface-velocity curves taken 10 feet in front of the lock gates in May, 1915, one on a rising and one on a falling tide, are reproduced in curve C, plate No. 74.

The location of the observations shown on curves A, B, and C are shown on the graphic.

The figures on the graphic noted as A-A is the result of special observations taken at station one on each section to try to determine the location of the so-called "neutral plane" and are representative of the conditions as they were at the place and time the observations were made and is not claimed to be a constant argument, but subject to slight variations based upon the following known conditions: (a) A rising tide opposes the outflowing fresh water. A falling tide has the opposite effect. (b) Current directions shown at stations with velocities of less than three-tenths foot per second should be viewed with suspicion. They are apt to be due to temporary causes; also the makers of the instrument set two-tenths foot per second as the limit for accuracy of the velocity register. (c) It is possible that the many drafts of water drawn—as high as 10 chambers a day—may have freshened the salt water sufficiently to interfere with maximum conditions late in the afternoon.

It is believed that the data are representative of the conditions in this locality.

The surface velocities may be found higher if the water in the lock chamber was doubly freshened as was the case in the investigation of May, 1915.

*Miscellaneous.*—Various estimates have been made during the year on the time of raising or lowering of Gatun and Miraflores Lakes to stated heights.

Fifteen ratings have been made at the Pedro Miguel current-meter rating station in 1915 and 1916, and all meters are now in good condition. Also one meter was rated and sold to the Panaman Government.

Some spilling was done through the Gatun Locks' culverts in January and February, 1916, during the repair work on Gatun spillway. Preliminary determinations of discharge, under above conditions, were made and results used in hydrologies of January and February, 1916.

The long-term average periods of water yield were altered on January 1, 1916, so as to begin on January 1, 1911, in the case of Gatun Lake, and January 1, 1902, in the case of Chagres River discharge at Alhajuela. Previous to 1911 conditions were not comparable to present conditions in the items of evaporation, seepage, retention in swamps, and rainfall direct into the lake. Also, Chagres River discharges at Alhajuela previous to 1902 were largely gotten by formulæ based on Gamboa-Alhajuela ratios applied to Gamboa measured discharges. The present system of records is based on actual measurements under conditions that will remain stable under the operation of the canal.

The following tables and plates accompany the hydrographical section of this report:

- Plate No. 74. Current velocity direction observations, Miraflores Locks.  
 Plate No. 75. Alhajuela average monthly discharges.  
 Plate No. 76. Total yield of Gatun Lake, 1915, and dry season, 1916.  
 Plate No. 77. Gatun Lake and Chagres River hydrographs, November 15-17, 1915.  
 Plate No. 78. Operating uses of Gatun Lake water supply, 1915, and dry season, 1916.  
 Plate No. 79. Alhajuela discharge mass curves.  
 Plate No. 80. Yields, storage and losses mass curves, Gatun Lake watershed.  
 Plate No. 81. Alhajuela discharge duration curve, 1902-1915, inclusive.  
 Plate No. 82. Gatun Lake total yield mass curves, 1912, 1911-1915, average, and 1915.  
 Table No. 8. Hydrology of Gatun Lake watershed, 1915.  
 Table No. 9. Hydrology of Gatun Lake watershed, dry season, 1916.  
 Table No. 10. Hydrology of Miraflores Lake watershed, 1915.  
 Table No. 11. Hydrology of Miraflores Lake watershed, dry season, 1916.  
 Table No. 12. Hydrology of Chagres, 1915.  
 Table No. 13. Hydrology of Chagres, dry season, 1916.  
 Table No. 14. Monthly discharge, Chagres River at Alhajuela, 1915.  
 Table No. 15. Monthly Gatun Lake hydrology, 1915.  
 Table No. 16. Principal freshets of 1915, and dry season, 1916.  
 Table No. 17. Maximum, minimum, and mean elevation, by months, at all stations, from January to December, inclusive, 1915.  
 Table No. 18. Ratios between principal water losses, Gatun Lake, 1915.

TABLE No. 8.—*Hydrology of Gatun Lake watershed, 1915.*

[Drainage area, 1,320 square miles.]

Gatun lockages, 1,310. Pedro Miguel lockages, 1,305.

	Elevation.	Date.
Gatun Lake:		
Yearly mean.....	86.17	
Maximum.....	87.20	Feb. 10
Minimum.....	84.96	Nov. 9

	Quantities.	
	Million cubic feet.	Second-feet.
Gatun spillway, waste.....	187,676	5,951.2
Gatun spillway, leakage.....	115	3.6
Gatun Locks, lockage and tests.....	5,384	170.7
Gatun Locks, leakage.....	338	10.1
Gatun hydroelectric plant.....	27,442	870.2
Pedro Miguel Locks, lockage and tests <sup>1</sup> .....	4,373	138.7
Pedro Miguel Locks, leakage <sup>1</sup> .....	181	5.7
Pumping at Gaillard Cut <sup>1</sup> .....	262	8.3
Brazos Brook Reservoir.....	230	7.4
Pumping at Gamboa.....	330	10.5
(a) Total outflow.....	226,330	7,176.4
(b) Storage (+increase, -decrease).....	-2,450	-77.7
(c) Net yield ( $a \pm b$ ).....	223,880	7,098.7
(d) Evaporation on lake (59.931 inches).....	23,094	732.3
(e) Total yield ( $c + d$ ).....	246,974	7,831.0
(f) Rainfall on lake (122.24 inches).....	46,988	1,490.0
(g) Yield from land area ( $e - f$ ).....	199,986	6,341.0
Transferred into Miraflores Lake <sup>1</sup> .....	4,816	152.7

	Mean area (square miles).	Rainfall (inches).	Run-off (inches).	Percentage (run-off).
Lake surface.....	165.8	122.2	122.2	100
Land area.....	1,154.2	118.6	74.5	63
Total watershed.....	1,320.0	118.2	80.4	68

<sup>1</sup> Transferred into Miraflores Lake.

TABLE NO. 9.—*Hydrology of Gatun Lake watershed, dry season 1916.*<sup>1</sup>

[Drainage area, 1,320 square miles.]

Gatun lockages, 158. Pedro Miguel lockages, 220.

	Elevation.	Date.
Gatun Lake:		
Season mean.....	86.34	
Maximum.....	86.75	Jan. 18-19
Minimum.....	85.91	Apr. 10

	Quantities.	
	Million cubic feet.	Second-feet.
Gatun Locks, waste and lake regulation.....	1,942.8	185.8
Gatun spillway, waste.....	316.8	30.3
Gatun spillway, leakage.....	38.1	3.6
Gatun Locks, lockage and tests.....	655.4	62.7
Gatun Locks, leakage.....	62.0	5.9
Gatun hydroelectric plant.....	10,373.7	992.3
Pedro Miguel Locks, lockage and tests <sup>2</sup> .....	563.0	53.9
Pedro Miguel Locks, leakage <sup>2</sup> .....	52.1	5.0
Pumping at Gaillard Cut <sup>2</sup> .....	14.4	1.4
Brazos Brook Reservoir.....	105.5	10.1
Pumping at Gamboa.....	149.7	14.3
Maintaining Miraflores Lake, through Pedro Miguel Lock <sup>2</sup> .....	597.3	57.1
(a) Total outflow.....	14,870.8	1,422.4
(b) Storage (+increase, -decrease).....	-1,950.0	-186.5
(c) Net yield (a±b).....	12,920.8	1,235.9
(d) Evaporation on lake (25.08 inches).....	9,657.5	923.8
(e) Total yield (c+d).....	22,578.3	2,159.7
(f) Rainfall on lake (11.19 inches).....	4,325.8	413.7
(g) Yield from land area (e-f).....	18,252.5	1,746.0
Transferred into Miraflores Lake <sup>2</sup> .....	1,226.8	117.4

	Mean area (square miles).	Rainfall (inches).	Run-off (inches).	Percentage (run-off).
Lake surface.....	166.4	11.2	11.2	100
Land area.....	1,153.6	12.1	6.8	56
Total watershed.....	1,320.0	12.0	7.4	62

<sup>1</sup> Dry season months are January, February, March, and April.<sup>2</sup> Transferred into Miraflores Lake.TABLE NO. 10.—*Hydrology of Miraflores Lake watershed, 1915.*

[Drainage area, 38.5 square miles.]

Miraflores lockages, 1,319.

	Elevation.	Date.
Miraflores Lake:		
Yearly mean.....	53.96	
Maximum.....	54.65	Aug. 20
Minimum.....	52.95	Oct. 1

TABLE NO. 10.—*Hydrology of Miraflores Lake watershed, 1915—Continued.*

	Quantities.	
	Million cubic feet.	Second-feet.
Miraflores spillway, waste.....	1,571	49.8
Miraflores spillway, leakage.....	89	2.8
Miraflores Locks, lockage and tests.....	4,661	147.9
Miraflores Locks, leakage.....	230	7.3
Miraflores power plant cooling water.....	410	13.0
Miraflores filter plant.....	21	.7
(a) Total outflow.....	6,984	221.4
(*) Total inflow from Gatun Lake <sup>1</sup> .....	+4,829	+153.1
(b) Storage (+increase, —decrease).....	—16	—0.5
(c) Net yield ( $a - * \pm b$ ).....	2,139	67.8
(d) Evaporation on lake (54.214 inches).....	202	6.4
(e) Total yield ( $c + d$ ).....	2,341	74.2
(f) Rainfall on lake (80.17).....	294	9.3
(g) Yield from land area ( $e - f$ ).....	2,047	64.9
Includes filtration plant wash water <sup>1</sup> .....	13	0.3

	Mean area square miles.	Rainfall (inches).	Run-off (inches).	Percentage (run-off).
Lake surface.....	1.6	80.2	80.2	100
Land area.....	36.9	83.0	23.8	29
Total watershed.....	38.5	82.9	26.2	31

<sup>1</sup> Includes filtration plant wash water.TABLE NO. 11.—*Hydrology of Miraflores Lake watershed, dry season 1916.*<sup>1</sup>

[ Drainage area, 38.5 square miles.]

Miraflores lockages, 163.

	Elevation.	Date.
Miraflores Lake:		
Season mean.....	53.60	
Maximum.....	54.40	Apr. 24
Minimum.....	51.40	Jan. 12

	Quantities.	
	Million cubic feet.	Second-feet.
Miraflores spillway, waste.....	91.0	8.7
Miraflores spillway, leakage.....	19.8	1.9
Miraflores Locks, lockage and tests.....	673.9	64.4
Miraflores Locks, leakage.....	192.8	18.4
Miraflores power plant cooling water.....	104.5	10.0
Miraflores Locks, wastage.....	4.6	.4
(a) Total outflow.....	1,086.6	103.4
(*) Total inflow from Gatun Lake <sup>2</sup> .....	1,230.7	117.7
(b) Storage (+increase, —decrease).....	+ 21.0	+ 2.0
(c) Net yield ( $a - * \pm b$ ).....	—123.1	—11.8
(d) Evaporation on lake (23.90 inches).....	88.9	8.5
(e) Total yield ( $c + d$ ).....	— 34.2	— 3.3
(f) Rainfall on lake (12.01 inches).....	44.6	4.3
(g) Yield from land area ( $e - f$ ).....	— 78.8	— 7.5
Includes filtration plant wash water <sup>2</sup> .....	3.8	.4

<sup>1</sup> Dry season months are January, February, March, and April.<sup>2</sup> Includes filtration plant wash water.

TABLE NO. 11.—*Hydrology of Miraflores Lake watershed, dry season, 1916*—Continued.

	Mean area (square miles).	Rainfall (inches).	Run-off (inches).	Percent- age (run-off).
Lake surface.....	1.6	12.01	12.01	100
Land area.....	36.9	11.05	.....	.....
Total watershed.....	38.5	11.09	.....	.....

TABLE NO. 12.—*Hydrology of Chagres, 1915.*

[Elevations are in feet above sea level and quantities in second-feet.]

Alhajuela. Drainage area, 427 square miles.

Low water (feet above mean sea level).....	91.0
Distance from Gatun (miles).....	38.5
Mean:	
Elevation (feet above mean sea level).....	93.22
Discharge.....	2,888
Maximum:	
Day of month, Nov. 15.	
Elevation (feet above mean sea level).....	104.32
Discharge.....	38,000
Minimum:	
Day of month, Apr. 1.	
Elevation (feet above mean sea level).....	91.47
Discharge.....	545
Percentage of yield at Gatun.....	{ 1 41 2 37
Length of records (years).....	
Compared with station average, total period, per cent above.....	10

TABLE NO. 13.—*Hydrology of Chagres, 1916.*<sup>3</sup>

[Elevations are in feet above sea level and quantities in second-feet.]

Alhajuela. Drainage area, 427 square miles.

Low water (feet above mean sea level).....	91.0
Distance from Gatun (miles).....	38.5
Mean:	
Elevation (feet above mean sea level).....	91.89
Discharge.....	1,003
Maximum:	
Day of month, Apr. 11.	
Elevation (feet above mean sea level).....	97.95
Discharge.....	13,858
Minimum:	
Day of month, Apr. 10-11.	
Elevation (feet above mean sea level).....	91.14
Discharge.....	474
Percentage of yield at Gatun.....	{ 4 46 5 81
Length of records (years).....	
Compared with station average, same seasons, per cent below.....	28

<sup>1</sup> Compared to net yield.<sup>2</sup> Compared to total yield.<sup>3</sup> Dry season months are January, February, March, and April.<sup>4</sup> Compared with Gatun total yield.<sup>5</sup> Compared with Gatun net yield.

TABLE No. 14.—*Monthly discharge, Chagres River, Alhajuela, 1915.*

[Drainage area, 427 square miles.]

Month.	Discharge in second-feet.				Run-off (depth in inches on water- shed).
	Maximum.	Minimum.	Mean.	Per square mile.	
January.....	3,670	932	1,544	3.61	4.162
February.....	20,300	769	2,104	4.93	5.134
March.....	1,446	571	943	2.21	2.548
April.....	27,085	545	2,237	5.24	5.846
May.....	21,820	991	3,138	7.35	8.474
June.....	16,706	1,576	3,185	7.46	8.323
July.....	18,042	2,629	4,196	9.83	11.333
August.....	11,200	1,809	2,811	6.58	7.586
September.....	10,640	1,720	2,920	6.84	7.631
October.....	27,720	1,883	3,832	8.95	10.318
November.....	38,000	2,491	4,387	10.27	11.459
December.....	24,367	1,547	3,362	7.87	9.073
The year.....	38,000	545	2,888	6.76	7.657

TABLE No. 15.—*Gatun Lake, 1915.*

[Drainage area, 1,320 square miles.]

1	2	3	4	5	6	7	8
Month.	Mean elevation above mean sea level.	Area for mean elevation.	Spillway discharge. <sup>1</sup>	Storage (+increase, -decrease).	Evaporation from lake sur- face.	Run-off net yield (4+5).	Total yield (4+5+6).
	<i>Fect.</i>	<i>Sq. miles.</i>	<i>Sec.-fect.</i>	<i>Sec.-fect.</i>	<i>Sec.-fect.</i>	<i>Sec.-fect.</i>	<i>Sec.-fect.</i>
January.....	86.98	167.4	2,587	— 16	929	2,570	3,500
February.....	86.98	167.4	4,325	— 118	871	4,207	5,077
March.....	86.82	166.8	1,335	— 512	969	823	1,792
April.....	86.46	166.4	5,705	— 305	863	5,400	6,263
May.....	85.68	164.6	7,761	— 1,650	765	6,111	6,876
June.....	85.44	162.5	6,306	+ 853	734	7,159	7,893
July.....	86.19	166.0	10,264	+ 112	591	10,376	10,967
August.....	86.02	166.0	6,968	— 19	627	6,949	7,576
September.....	86.03	166.0	7,618	— 96	641	7,522	8,163
October.....	86.02	166.0	11,922	+ 373	608	12,295	12,903
November.....	85.35	164.3	14,871	— 860	525	14,010	14,535
December.....	86.12	166.0	6,374	+ 1,299	670	7,673	8,344
The year...	86.27	165.8	7,170	— 78	733	7,091	7,824

<sup>1</sup> Includes leakages, lockages, pumping, and power water.TABLE No. 16.—*Principal freshets of year 1915 and dry season 1916.*

Date of be- ginning.	Vigia.		Alhajuela.				Gamboa.				
	Eleva- tion of crest.	Rise.	Eleva- tion of crest.	Rise.	Hours after Vigia.	Maxi- mum dis- charge, c. f. s.	Eleva- tion of crest.	Rise.	Hours after Vigia.	Per cent of Vigia rise.	Per cent of Alhajuela rise.
1915.	<i>Fect.</i>		<i>Fect.</i>				<i>Fect.</i>				
Feb. 10.....	137.4	7.8	100.1	5.8	14	20,308	87.19	0.05	.....	0.6	0.9
Apr. 3.....	140.6	15.2	102.4	10.8	14	27,100	86.82	None.	.....	.....	.....
Apr. 4.....	139.6	8.8	102.0	6.0	14	26,000	86.73	.09	.....	.08	1.0
May 7.....	136.0	10.4	99.8	7.7	14	19,384	86.55	.09	.....	.9	1.0
May 21.....	136.0	9.2	99.9	6.8	14	19,692	85.47	.07	.....	.08	1.0
May 26.....	137.5	9.9	100.6	7.0	14	21,962	85.60	.19	34	2.0	3.0
June 28.....	135.4	8.0	99.1	5.6	14	17,294	85.67	.22	17	3.0	4.0
June 30.....	135.0	8.3	99.9	5.8	14	16,706	85.99	.19	14	3.0	3.0
July 8.....	135.4	8.5	99.4	6.2	14	18,042	86.77	.23	3	3.0	4.0
Oct. 30.....	135.6	9.0	99.5	6.6	14	18,480	86.16	.19	.....	2.0	3.0
Oct. 31.....	139.0	10.4	102.2	7.6	14	27,950	86.33	.30	44	3.0	4.0
Nov. 15.....	142.7	15.0	104.3	10.5	14	38,000	85.69	.29	23	3.0	3.0
Nov. 17.....	136.2	7.8	99.6	5.4	14	18,930	85.57	.07	13	1.0	1.0
Dec. 2.....	138.4	10.4	101.3	7.3	14	24,369	86.15	.10	.....	1.0	1.0
Dec. 3.....	137.7	8.2	100.8	5.6	14	22,640	86.12	.07	12	.8	1.0
1916.											
Apr. 11.....	133.3	8.0	98.0	6.4	14	13,858	86.27	.30	.....	.....	.....

TABLE NO. 17.—*Monthly maximum, minimum, and mean elevations for Gatun Lake, Miraflores Lake, and Chagres River, 1915.*

1915.	Gatun Lake.								
	Gatun.			Trinidad.			Monte Lirio.		
	Maxi- mum.	Mini- mum.	Mean.	Maxi- mum.	Mini- mum.	Mean.	Maxi- mum.	Mini- mum.	Mean.
January.....	87.06	86.90	86.98	87.06	86.93	87.01	87.07	86.96	87.00
February.....	87.20	86.88	86.98	87.22	86.86	87.00	87.14	86.88	86.99
March.....	86.98	86.60	86.82	87.02	86.63	86.82	86.99	86.61	86.81
April.....	86.89	86.37	86.46	86.86	86.28	86.45	86.93	86.34	86.48
May.....	86.54	85.36	85.68	86.55	85.31	85.67	86.56	85.38	85.71
June.....	85.96	85.35	85.44	85.93	85.35	85.45	86.00	85.40	85.50
July.....	86.62	85.96	86.19	86.61	85.93	86.20	86.65	86.00	86.25
August.....	86.15	85.80	86.02	86.14	85.78	86.01	86.16	85.81	86.05
September.....	86.27	85.92	86.03	86.19	85.92	86.02	86.20	85.97	86.07
October.....	86.18	85.95	86.02	86.21	85.94	86.02	86.31	86.00	86.05
November.....	86.18	84.96	85.35	86.15	84.95	85.35	86.19	84.97	85.37
December.....	86.54	85.69	86.12	86.53	85.73	86.13	86.55	85.70	86.15
The year.....	87.20	84.96	86.17	87.22	84.95	86.18	87.14	84.97	86.20

1915.	Gatun Lake.								
	Bohio.			Frijoles.			San Pablo.		
	Maxi- mum.	Mini- mum.	Mean.	Maxi- mum.	Mini- mum.	Mean.	Maxi- mum.	Mini- mum.	Mean.
January.....	87.07	86.98	87.01	87.07	86.98	87.02	87.07	86.97	87.01
February.....	87.21	86.93	87.02	87.25	86.93	87.03	87.19	86.92	87.01
March.....	87.04	86.61	86.86	86.99	86.63	86.84	87.02	86.49	86.85
April.....	86.85	86.35	86.50	86.83	86.30	86.48	86.83	86.30	86.47
May.....	86.56	85.41	85.74	86.59	85.39	85.72	86.54	85.39	85.71
June.....	86.05	85.41	85.54	86.00	85.37	85.51	85.99	85.37	85.51
July.....	86.66	86.00	86.25	86.72	86.01	86.26	86.68	85.98	86.26
August.....	86.15	85.85	86.02	86.15	85.84	86.04	86.16	85.81	86.04
September.....	86.18	85.94	86.05	86.15	85.93	86.03	86.16	85.93	86.04
October.....	86.26	86.00	86.09	86.26	85.99	86.07	86.27	85.97	86.07
November.....	86.19	84.97	85.40	86.20	84.98	85.44	86.21	84.98	85.40
December.....	86.60	85.76	86.19	86.58	85.75	86.19	86.59	85.78	86.16
The year.....	87.21	84.97	86.22	87.25	84.98	86.22	87.19	84.98	86.21

1915.	Gatun Lake.								
	Gamboa.			Pedro Miguel.			Juan Mina.		
	Maxi- mum.	Mini- mum.	Mean.	Maxi- mum.	Mini- mum.	Mean.	Maxi- mum.	Mini- mum.	Mean.
January.....	87.11	86.70	86.99	87.95	85.87	86.98	87.11	86.85	86.99
February.....	87.19	86.79	86.97	87.82	86.03	86.96	87.35	86.80	86.99
March.....	87.05	86.48	86.81	88.00	85.58	86.80	87.04	86.57	86.81
April.....	86.90	86.12	86.44	87.50	85.25	86.45	87.23	86.26	86.47
May.....	86.56	85.19	85.66	87.37	84.31	85.66	86.72	85.33	85.72
June.....	85.99	85.16	85.45	86.46	86.44	85.46	86.21	85.28	85.50
July.....	86.77	85.82	86.19	87.35	85.17	86.19	87.08	85.94	86.23
August.....	86.21	85.74	86.02	86.82	85.01	85.99	86.32	85.80	86.04
September.....	86.26	85.82	86.02	86.89	84.90	86.00	86.53	85.87	86.07
October.....	86.35	85.91	86.01	87.30	83.74	85.87	87.42	85.92	86.04
November.....	86.30	84.86	85.33	87.00	84.62	85.54	87.20	84.93	85.39
December.....	86.56	85.70	86.14	86.98	84.70	86.04	86.58	85.69	86.19
The year.....	87.19	84.86	86.17	88.00	83.74	86.16	87.42	84.93	86.20

TABLE NO. 17.—*Monthly maximum, minimum, and mean elevations for Gatun Lake, Miraflores Lake, and Chagres River, 1915—Continued.*

1915.	Chagres River.						Miraflores Lake.		
	Alhajuela.			Vigia.			South end Pedro Miguel lock.		
	Maxi- mum.	Mini- mum.	Mean.	Maxi- mum.	Mini- mum.	Mean.	Maxi- mum.	Mini- mum.	Mean.
January.....	94.05	91.86	92.54	129.02	126.50	127.06	54.12	53.43	53.79
February.....	100.10	91.73	92.76	137.40	126.35	127.46	54.42	53.60	54.02
March.....	92.42	91.49	91.89	126.80	125.25	125.97	54.43	53.45	54.03
April.....	102.35	91.47	92.85	140.60	125.20	126.79	54.08	53.46	53.81
May.....	100.60	91.99	93.44	137.50	125.45	127.36	54.28	53.60	53.93
June.....	98.90	92.40	93.44	135.00	126.10	127.26	54.21	53.55	53.93
July.....	99.35	93.11	94.00	135.38	126.90	128.05	54.33	53.60	54.04
August.....	97.00	92.56	93.17	132.25	126.10	126.93	54.65	53.65	54.06
September.....	96.80	92.50	93.29	131.90	126.10	127.11	54.40	53.00	53.93
October.....	102.15	92.61	93.75	139.00	126.40	127.74	54.47	52.95	54.02
November.....	104.32	93.02	94.03	142.70	126.40	128.02	54.38	53.70	54.08
December.....	101.27	92.38	93.44	138.40	125.90	127.29	54.47	53.25	53.88
The year.....	104.32	91.47	93.22	142.70	125.20	127.25	54.65	52.95	53.96

TABLE NO. 18.—*Gatun Lake, 1915.*

[Ratios between principal water losses.]

Month.	Spillway waste was X times—						Lockage water was X times—				
	Hydro- electric.	Lock- ages.	Evapo- ration.	Net yield. <sup>1</sup>	Neces- sary losses. <sup>2</sup>	Total yield. <sup>3</sup>	Hydro- electric.	Evapo- ration.	Net yield. <sup>1</sup>	Neces- sary losses. <sup>2</sup>	Total yield. <sup>3</sup>
	Value of X.						Value of X.				
January....	1.3	3.9	1.3	0.5	0.9	0.4	0.3	0.3	0.10	0.2	0.10
February....	3.8	9.8	3.6	.7	2.6	.6	.4	.4	.08	.3	.06
March.....	.2	.3	.1	.2	.1	.1	.5	.4	.50	.3	.20
April.....	7.2	12.4	5.4	.9	4.4	.7	.6	.4	.07	.4	.06
May.....	10.0	16.6	8.7	1.1	6.0	1.0	.6	.5	.07	.4	.06
June.....	7.1	12.5	7.0	.7	4.4	.7	.6	.6	.06	.4	.05
July.....	11.2	20.4	15.2	.9	6.9	.8	.5	.7	.04	.3	.04
August.....	5.5	14.0	8.8	.8	3.8	.7	.4	.6	.06	.3	.05
September..	6.2	19.7	9.7	.8	4.5	.8	.3	.5	.04	.2	.04
October.....	10.5	62.7	17.6	.9	8.5	.9	.2	.3	.01	.1	.01
November...	13.6	268.2	26.2	1.0	12.4	.9	.05	.1	.004	.05	.004
December...	5.2	56.7	7.8	.7	4.6	.6	.09	.1	.01	.08	.01
Year...	6.8	19.2	8.1	.8	4.9	.76	.36	.42	.04	.25	.04

<sup>1</sup> Net yield is inflow evaporation.<sup>2</sup> Necessary losses is the sum of leakages, hydroelectric, lockages, municipal, and sanitary water losses.<sup>3</sup> Total yield is total inflow.

NOTE.—X means that there were as many times as shown in columns water used through the spillway or in lockages as at hydroelectric plant, lockages, etc.; i. e., in January, 1915, there was 1.3 times as much water wasted through the spillway as was used in making hydroelectric power.

## SECTION OF SURVEYS.

The section of surveys continued its work of maintaining, checking, and recording the locations of Canal Zone boundary monuments, triangulation points, and bench marks. A survey of the 100-foot contour about Gatun Lake was completed during the year, and monuments were set to mark its location. This section has handled all



survey work in connection with the permanent location of buildings, water and sewer lines, changes in tracks on locks and dams, and has made various surveys and maps for other divisions.

The details of the work accomplished by this section are covered in the report of the assistant engineer, which follows:

#### SECTION OF SURVEYS.

*O. E. Malsbury, assistant engineer.*

##### BUILDING LOTS.

Colon:	
Corner and grade stakes.....	247
Alley stakes.....	187
Folks River, corner and grade stakes.....	
Cristobal, corner and grade stakes.....	1
Balboa, corner and grade stakes.....	1
Santa Cruz, Panama, corner and grade stakes.....	9
Guachapali, Panama, corner and grade stakes.....	2
Las Esplanadas, corner and grade stakes.....	5
Total stakes set on.....	lots.. 453

*Colon monuments.*—Sixty-nine block monuments were set.

*Colon, regular lots.*—Surveys and maps were made showing the two houses on lot 558, the houses and fence lines on lots 18 and 19, block 27, the buildings on lots 209 and 304, the separate areas occupied by the two houses on lot 213, and the dimensions and areas in meters and square meters for lots 16, 17, 18, and 19, block 54.

*Colon, miscellaneous lots.*—A survey was made including those lots along the west shore, and those of temporary layout in the stable district. A special map was prepared showing the western group; the stable lots were shown in dim outline over the approved layout on the 1 to 1,200 map of Colon.

The shore to the east of the stable district was monumented and tied in to the stable district.

A corral lot was staked out on Colon Beach near the slaughterhouse, and a map prepared showing its area and location.

Survey and map were made showing the conflict of the proposed quarantine reservation enlargement on garden lot 3001.

A survey was made and a map prepared showing the location of a 1-acre tract of land on Colon Beach, about 300 feet north of the slaughterhouse. A tie was made to the Colon lot layout monuments.

*Cristobal lots.*—A survey was made locating houses and curb lines on a plat of ground just south of the Cristobal Hotel. A map was drawn up on a scale of 1 to 240 showing three lots.

*Las Esplanadas, Panama.*—A survey was made and a map prepared showing the location of houses, curb and street lines, sea wall, etc., of that part to the south of Avenue Sur. Monuments were set and referenced.

A survey was made and a map prepared making a redivision of the block comprising lots 1-5, section A.

A survey was made and a map prepared showing the encroachment into lot 15 of the house on lots 12, 13, and 14, section A.

*San Doval stable lots.*—Corner and grade stakes were set on 11 lots. A fishplate monument was set at the north end of the tract, and reference points were cut on the concrete roadway. A survey was made and a map prepared showing lots 1-a to 1-f and 12-a to 12-f, also roads, buildings, and bounding lines.

*Santa Cruz.*—Survey and map were made of a garden plot back of block 28, for lease to Mr. A. Lockerson.

The Ramirez-Marquez line was restaked for the building of a fence line.

*Pueblo Nuevo.*—The Panama Railroad Santa Cruz estate boundary line was staked out through the village of Pueblo Nuevo.

The boundary lines of two tracts of land in Pueblo Nuevo were replotted and the areas checked.

## • GATUN DAM.

*Settlement hubs.*—Regular monthly readings have been taken and reported. The settlement for the year is normal. For example, the settlement in contour, plus 95, East Valley, South Toe, is  $3\frac{1}{2}$  inches for the year, as compared to 4 inches per year for the previous 18-month period.

*B. M.'s. "D" and "L2."*—B. M. "D" has consistently settled, the total for the year being 0'.234.

B. M. "L2" has continued to rise as its movement indicated the last three months of the previous year. The total upward movement, however, was very slight, being 0'.017.

*Bench marks.*—Bench mark W-25 was replaced in the West Valley by a permanent bench mark designated by the letter "I"; a permanent bench mark "H" was established in the borrow pit near the old signal tower; a permanent bench mark was established on the northeast pier of the west emergency dam, to be used as a datum for all settlements in the East Valley. It is designated by the letter "G."

A precise level circuit was run from P. B. M. 6 through all the bench marks in both valleys, and corrections made.

*South approach wall.*—The readings on the south approach wall show consistent settlement—minimum near the break (A1, 0'.047); large at the end (E and W, 0'.241); and maximum at the middle (A4, 0'.278).

The reference bench mark on the center wall, 218 feet north of the break, was tied in to the P. B. M. datum plane, and its recorded elevation was found to be 0'.224 high. No change was made.

*Cano Saddle.*—The profile of Cano Saddle was run four times during the year. The settlement is slight, ranging from 0'.00 to 0'.13.

*Mindi Levee.*—The profile of Mindi Levee was run once during the year.

*Tracks.*—A transit and chain survey was made, and a map prepared on a scale of 1 to 4,000, showing the tracks on the Gatun Dam, locks, borrow pit, Mindi Levee, and connections with the main line of the Panama Railroad.

Surveys were made and the 1'-50' scale maps of the Pedro Miguel and Miraflores Locks were revised, showing in detail the connections of the tracks.

Survey and map were made of a section west of Miraflores Locks, showing 1-foot contours.

*Hydroelectric station.*—Bench marks were established in the forebay, tailrace, tops of turbine wheel, casings, and in the pressure gauge pipes in the power house, to be used in connection with power tests.

## PRECISE LEVEL BENCH MARKS.

*Repairs.*—The following bench marks were cleared and repaired: 28A (Gorgona), 27A (Juan Grande), 22A, 42 (Cardenas Hill), 42A, 43, 43A, 44, 44A, 38 (Paraiso), 38A (Paraiso), 39 (Pedro Miguel), 39A, 40 (Tank Hill), 40A, 37 (Cucaracha), 37A (Cucaracha), 35 (Lirio), 34 (Empire), 33 (Whitehouse), 32 (Las Cascadas), 30 and 30A (Matachin), 29 and 29A (Gorgona Shops), 26A (Mamei), 24A (Caimito), 25 and 25A (Bailamonos), 23A (San Pablo), 20A, 19A, and 18A.

A monument on a ridge near Tabernilla dumps was taken up. It was probably meant for 21A, but was never incorporated into the system.

*Transfers.*—P. B. M. 45 (Balboa): The pipe was shortened to conform to the grading in front of building No. 14, and was later transferred on account of change of plans.

P. B. M. 7A (Gatun): This bench mark was transferred on account of new grading.

*Corrections.*—P. B. M. 7 (Gatun): A correction of 0'.013 was applied to this bench mark in accordance with the result of a circuit of precise levels through P. B. M. 6.

P. B. M. 36 (Culebra): This bench mark was published destroyed by the slides on the canal.

*P. B. M. tide gauges.*—Colon: The tide gauge register bench mark was checked in July and September.

Pier No. 18, Balboa: Four bench marks were established in accordance with the P. B. M. datum plane, and the gauge rod set.

*P. B. M. datum versus Gatun Lake level.*—A series of readings were taken in March from the P. B. M. datum onto the Gatun Lake level at Pedro Miguel, Gamboa, Darien, Frijoles, and Gatun. The readings were highest at Darien, as in the readings of the previous year.

## ZONE TRIANGULATION STATIONS.

*Slide commission.*—In line with a systematic study of the slides, and with the object of determining whether the hills are moving en masse, triangulation stations were established on Gold Hill, Zion Hill, Contractor's North, and Contractor's South, tied into the Zone system. Azimuths, distances, and coordinates were computed. The chained distance between Contractor's North and South checked the computed distance to 0'.02.

In addition to the above the angle was measured from  $\Delta$  Luisa, between points on either side of the canal, and between the fixed point  $\Delta$  Gordo and  $\Delta$  Gold Hill.

Three months after the stations were established angles were read, showing no movement.

*Various stations.*—Some work was done to incorporate the east tower of the Colon wireless into the Zone system.

A reconnaissance trip was made to Cerro Escalante, and it was sketched onto the 1-20,000 map of the Canal Zone.

The triangulation station at Ancon was repaired twice during the year.

## CANAL ZONE BOUNDARY LINES.

The monumenting of the boundary lines between the Canal Zone and the cities of Panama and Colon, in accordance with the treaty proclamation of February 18, 1915, was finished.

*Panama.*—A regulation concrete monument was set on the Corundu River, near Bridge No. 65 of the old Panama Railroad; the stone bridge on the Corozal road and the concrete bridge on the Tumba-Muerta trail were stenciled; a brass plug was set in the concrete curb at the junction of the Corral and Tivoli roads, and an iron spike was driven in the center of the Tivoli road at an angle point on the boundary line.

*Colon.*—Sixteen monuments were set on line and several brass plug reference points were set on the offset line in Folks River. An iron rail was set in concrete at Old Point A, Folks River. Brass bolts were set in the sea walls at both ends of the line. One monument was replaced. The azimuth line of Colon Harbor was staked out across the fill at the Cristobal fire station. All regular concrete monuments were properly stenciled.

*100-foot contour.*—The 100-foot contour survey was started and finished within the year, with a total of 843 monuments set, as follows:

Continuous 100-foot contour.....	734
Isolated 100-foot contour (Peninsula).....	95
Continuous 100-foot contour (on 5-mile line).....	10
Isolated 100-foot contour (on 5-mile line) (Peninsula).....	4

Monuments set on the 5-mile line were numbered consistently with the monuments on this line, using the fractions  $\frac{1}{2}$ ,  $\frac{1}{4}$ , etc. The regular 5-mile line type of monument was also used.

The other monuments were numbered consecutively up one side of a valley and down the opposite side, working on the east side of the canal from the Chagres Valley to the north and on the west side of the canal from the Trinidad to the south. Fractional numbers were used occasionally to take care of special cases of omitted numbers.

Blocks of numbers were assigned to each valley. The end numbers and the total number set per valley are as follows:

Chagres Valley, 1 to 66, total.....	70
Gatun Valley, 100 to 251, total.....	156
Trinidad Valley, 300 to 817, total.....	525
Cano Valley, 900 to 989, total.....	92

Shore line, contour, and island corrections were sketched, with the help of pocket compasses. Cultivations and improvements below the 100-foot contour were also sketched for the use of the special attorney.

*Five-mile boundary.*—The Canal Zone boundary line was cleared from monument No. 90 in the direction of Chivo Chivo Hill to a few hundred feet beyond monument No. 84.

As noted above in the Gatun Lake survey, monuments were set wherever the 100-foot contour crossed the 5-mile line. Fourteen monuments were set in this manner.

## TERMINALS.

*Atlantic*.—Precise tape measurements were taken on four sections of the Cristobal coaling plant bridge span, making a satisfactory check.

*Pacific*.—A survey was made locating buildings, duct lines, etc., at Dry Dock No. 1. The old precise level bench marks were checked and new ones set. Assistance was rendered in preparing drawings and checking computations on the track layout.

## FUEL-OIL STORAGE.

*Mount Hope*.—Cross sections were taken on the fire walls of tanks Nos. 10 and 41, and on the walls between the tanks of the Panama Canal Storage Co. and the Texas Co. The sections were plotted and the yardage computed.

Corner stakes were reset on lots Nos. 26 and 48. Elevations were determined for tanks on the following lots: 26, 48, 10, 41, 4, and 28.

*Balboa*.—Survey was made to determine the rate and total settlement of tank No. 37. A survey was made of the lot layout of the West Coast Oil & Fuel Co. (Ltd.), corner, center, and grade stakes being set, and a map prepared showing the tanks, connections, and fire walls.

Lots 1, 2, 3, and 4, as shown on plan No. 4197, were restaked into three lots. Fire walls on lots 13 and 14 were checked for elevations, slope, and grading, and results shown on plan.

## JOINT LAND COMMISSION.

Surveys were made and maps drawn up showing boundary lines, areas, and improvements on various estates, as noted below:

*Mandinga*.—Survey completed.

*Alba*.—Area of fresh-water swamps determined; also areas of Islands Nona and Zurita determined.

*San Juan*.—Area of monglare determined.

*Rio Congo*.—Survey and map.

*Punta Mala proper*.—Survey and map were made showing areas of various owners.

*El Trapiche and Chorilla de la Pena*.—A map was drawn up from previous surveys showing the areas of these two properties, and a conflict between them of 0.58 hectare.

*Guabal*.—Maps were drawn up showing different interpretations of the description with reference to the conflict with the Cocoli and Velasquez.

*E. J. R. Evans*.—Survey and map of his pastures were made.

*San Jose*.—A map was prepared and a report submitted re conflict with the Mata Redonda estate.

*Arcia-Bracho pastures*.—Survey and map were made.

*Rio Indio tract*.—The area of that part on the south bank of the Rio Chagres taken from the Harrison-Arosemena map was found to be 1,200 hectares.

*Bernadino*.—Survey was made to show that this estate lies entirely without the Canal Zone.

*San Lazaro tract*.—A map was made showing the boundary lines and area.

*Sabana Grande*.—Survey and maps were made; also a traverse of the Rio Chilibre from the mouth of the Rio Agua Buena to the Rio Pedernal was made.

*Barro Colorado Arriba*.—A sketch map was prepared showing boundary lines and area.

*Margarita cane fields*.—Survey and map were made.

*Loma Pedragosa*.—The map and areas of this estate were checked and found to agree with the survey.

*Viafara tract*.—The location of this tract was shown on the "Map of the Northeastern Part of the Canal Zone."

## SUPPLY DEPARTMENT PASTURES.

*Mount Hope*.—Survey and map were made of the commissary pasture, bounded on the north by the Margarita Railroad and the Rio Puerto Escondido, on the east by Gatun Lake, on the south by Brazos Brook Reservoir and the Gatun Road, and on the west by the East Diversion, showing all main fences, drainage, high ground and swamp and the dividing line between the property of the Panama Railroad and The Panama Canal on the one side and the property of Messrs. Arcia and Bracho on the other side.

*New Culebra*.—A tract was cleared through the property for inspection purposes. A map was prepared showing the dividing lines of the tracts to be cleared, areas, and drainage. Trochas were started on the dividing lines.

Surveys were made to determine the areas cleared by contract on both of the above.

## GENERAL SURVEYS.

*Union Oil Co., Balboa.*—Survey and map were made showing the location of the buildings of the Union Oil Co. at Balboa. A table was prepared showing the area of each of the seven buildings, the area of each with a 15-foot allowance all around, and the area of the seven buildings taken in a square with a 15-foot allowance all around.

*Removal of Chagres to Lagarto.*—Inspection trips were made down the coast from Colon to Lagarto, and by trail from Cano Saddle to the Rio Lagarto, and thence by cayuca to the village of Lagarto.

A stadia survey of the trail was made from the village of Chagres to Lagarto, and compass traverses were made up the Rio Lagarto, Cano Quebrada, and Mosquera to the end of cayuca navigation in each case. A compass survey was made of the trail from Cano Saddle to the Rio Lagarto.

A townsite was cleared and laid off into lots on the north bank of the Rio Lagarto.

*Topography of Gamboa.*—A topographical survey and map were made covering the area 1,500 feet to the east of Gamboa Bridge, the lake, and up to the 100-foot contour on the north bank showing 5-foot contours.

## MISCELLANEOUS.

*Ordnance reservation.*—An ordnance reservation was staked out and monumented at Corozal. Map and description were drawn up.

*Palo Seco leper colony.*—A map was prepared showing the boundary lines, monuments, and military trail in the reservation.

*Water and land areas, Canal Zone.*—The total area between the 5-mile limits and the coast lines, the Gatun and Miraflores Lake areas and the land area within these limits, and the total Gatun Lake area up to the 87-foot contour were determined for the Census Bureau.

*Power cable, Gatun to Toro Point.*—A survey was made staking out the line. Ranges were set for crossing the bay, and the range lines were monumented after the cable was laid.

*Examinations.*—Examinations for levelmen and transitmen were given in August and February.

*1-20,000 map.*—Additional data were put on the 1-20,000 map of the Canal Zone from various surveys and maps.

*Rim of Chagres Basin.*—The coordinates and elevations of the controlling points on Santa Rita ridge line, and the elevations of three points on the Trinidad ridge were computed. Elevations were computed for the points on the rim of the Chagres Basin, as shown on the 1-100,000 map of 1912, by reducing the notes of the traverses of the various branches of the Chagres River.

*Odd jobs.*—Assistance was rendered in making a stadia survey of the Culebra slides and in the tests on the floating crane *Ajax*. The area of Panama City, in accordance with the treaty proclamation of February 18, 1915, was determined. Working drawings were made of the following camp equipment: Pack sacks, stadia boards, and cots. A base line was laid out and the intervals of various transits determined. Philadelphia level rods, Brandis precise-level rod, and stadia boards were relined and restenciled. Comparison was made of five standardized Lufkin steel tapes with the Invar tape. Examination and disposition was made of numerous field-note books, and 800 old French maps.

*Miles of line.*—Transit, 57.30; Y-level, 303.86; precise level, 30.43; stadia traverse, 175.53; side shots, 151.01; hand level, 15.34; compass, 34.28; clearing, 7.95. Total miles of line, 775.7.

## SECTION OF OFFICE ENGINEER.

The section of office engineer has continued the conduct of the drafting forces of locks operation and maintenance, electrical division, municipal division, division of terminal construction, and the building division; has conducted the issue of all necessary prints, and has continued in the work of preparation of specifications, requisitions, and prints accompanying the same.

The details of the work accomplished and of the force employed are given in the report of the office engineer, which follows:

# SECTION OF OFFICE ENGINEER.

*C. J. Embree, office engineer.*

During the past year we have employed an average of 40 draftsmen, who have been assigned to work as follows:

	Men.
Building division.....	23
Terminal construction.....	12
Electrical division.....	2
Municipal division.....	1
Office engineer, for general assignment.....	2
Total.....	40

During the year we have issued a total of 1,352 tracings, spending a total of 8,356 man-days in their preparation, or 6.18 man-days per tracing.

The number of tracings issued by each section of the drafting room is as follows:

Building division.....	764
Terminal construction.....	283
Municipal division.....	50
Electrical division.....	88
Office engineer for Panama Railroad, health department, executive office, locks division, etc.....	167
Total.....	1,352

In addition to the drafting work of this office, we have maintained a blue-print room for issuing prints to the field for construction purposes, as well as making up the necessary record prints and negatives for ordering material in the States.

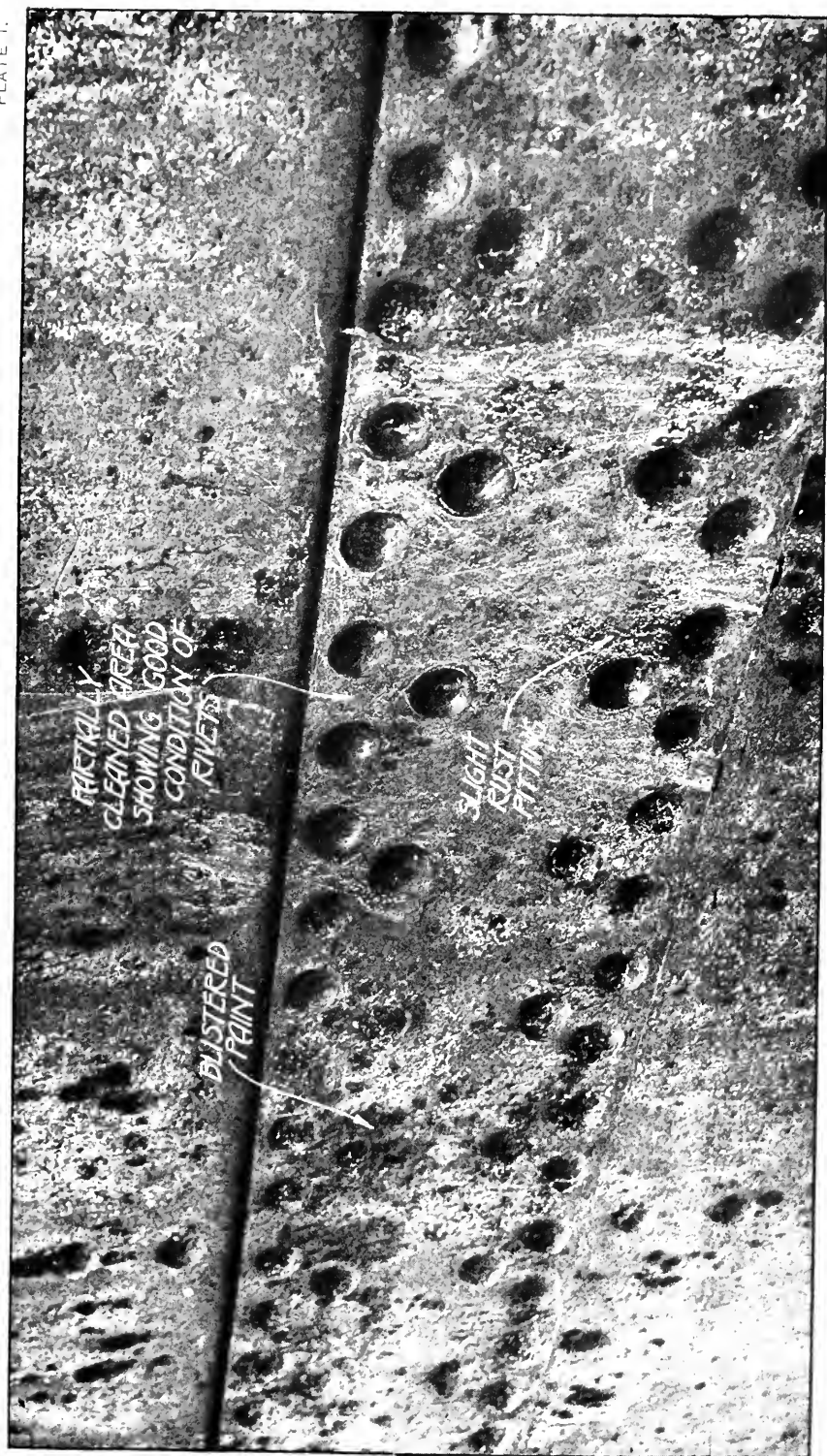
	Square feet.
Blue prints issued.....	312,318
White prints issued.....	84,002
Brown prints issued.....	13,749
Cloth blue prints issued.....	957
Total.....	411,026

In addition to the general drafting-room work, we have maintained a record of all stock spare parts for the locks division, writing specifications, and placing requisitions for stock required to replace worn-out or damaged electrical and mechanical parts.

Respectfully,

CHESTER HARDING,  
*Engineer of Maintenance.*

Maj. Gen. GEO. W. GOETHALS, United States Army,  
*Governor, The Panama Canal, Balboa Heights, Canal Zone.*



MIRAFLORES LOCKS. LOWER BUTT STRAP, GATE NO. 119.

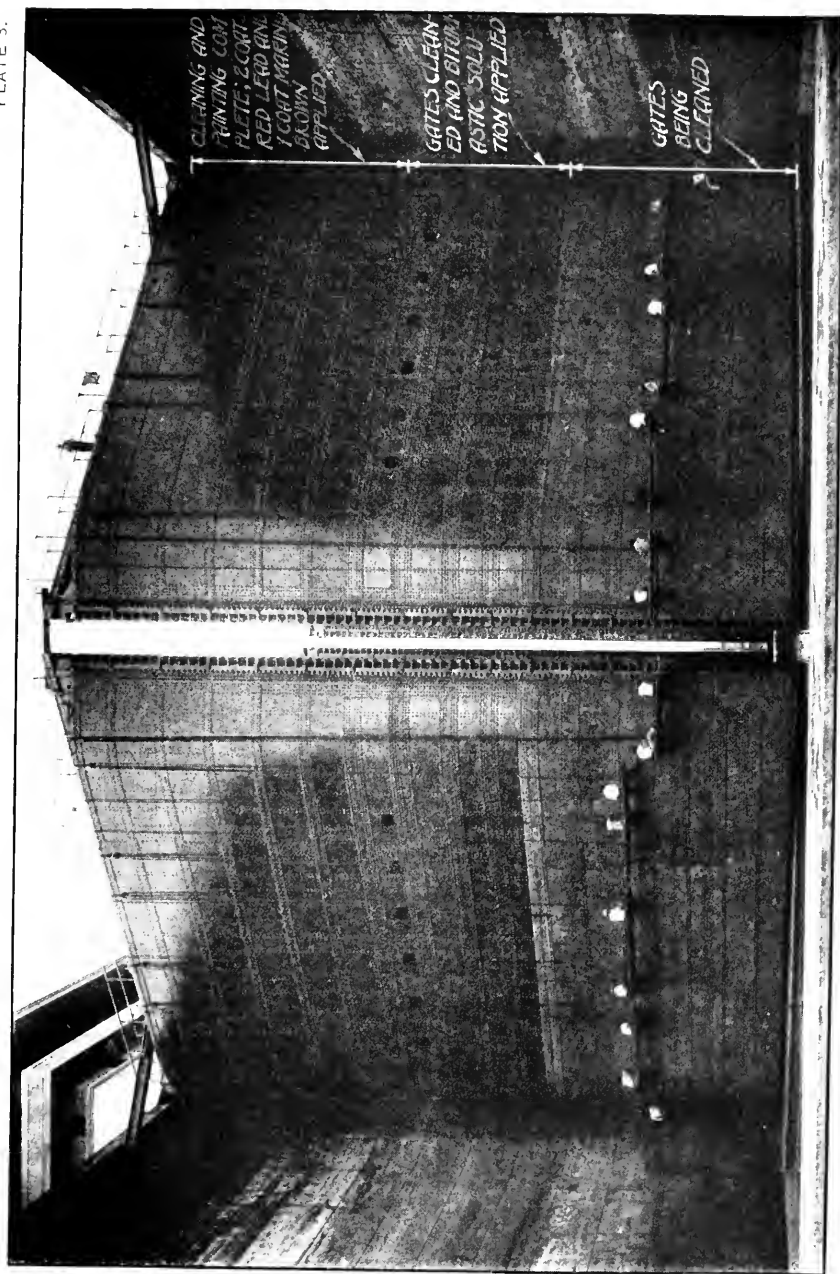




MIRAFLORES LOCKS. BLISTERING OF PAINT AND RUST SPOTS ON GATE NO. 119.

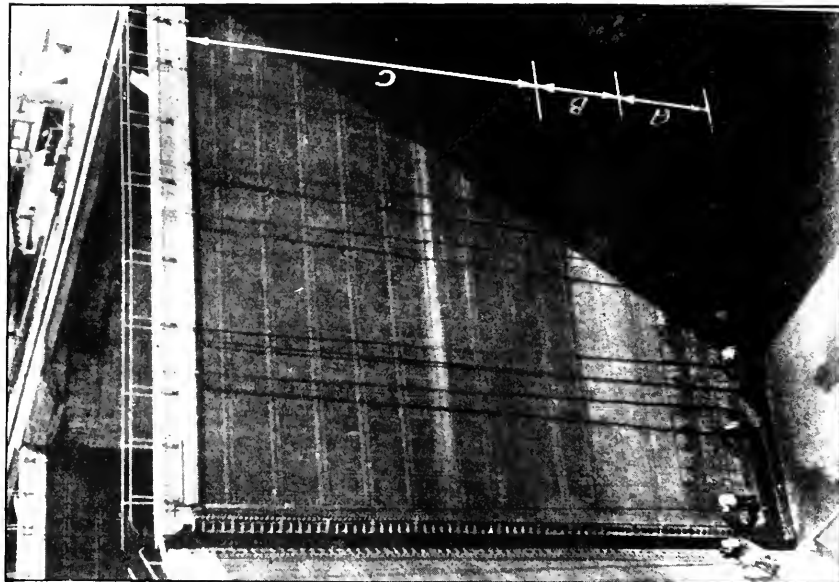


PLATE 3.



MIRAFLORES LOCKS, CLEANING GATES NOS. 114 AND 115.

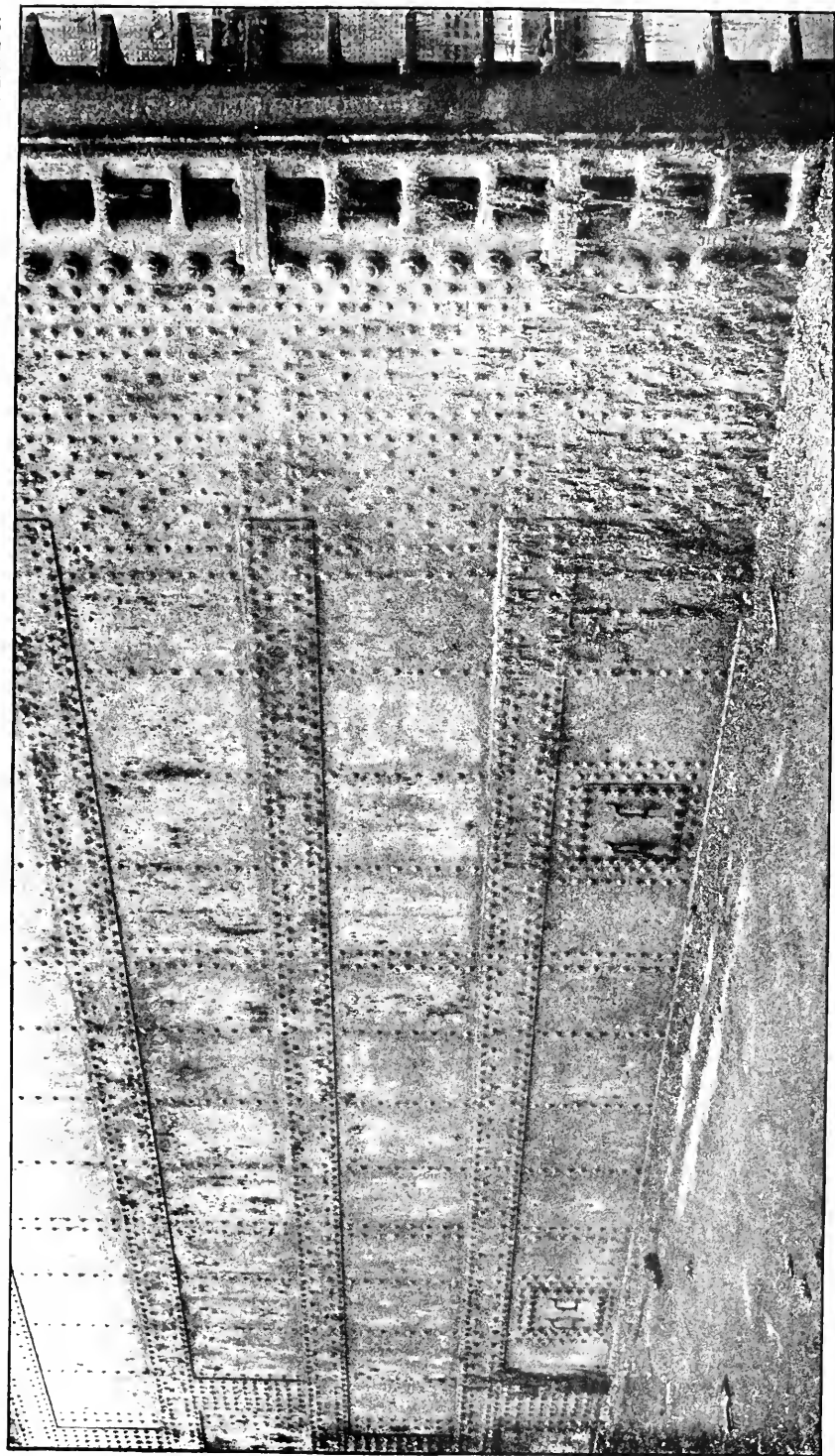
PLATE 4.



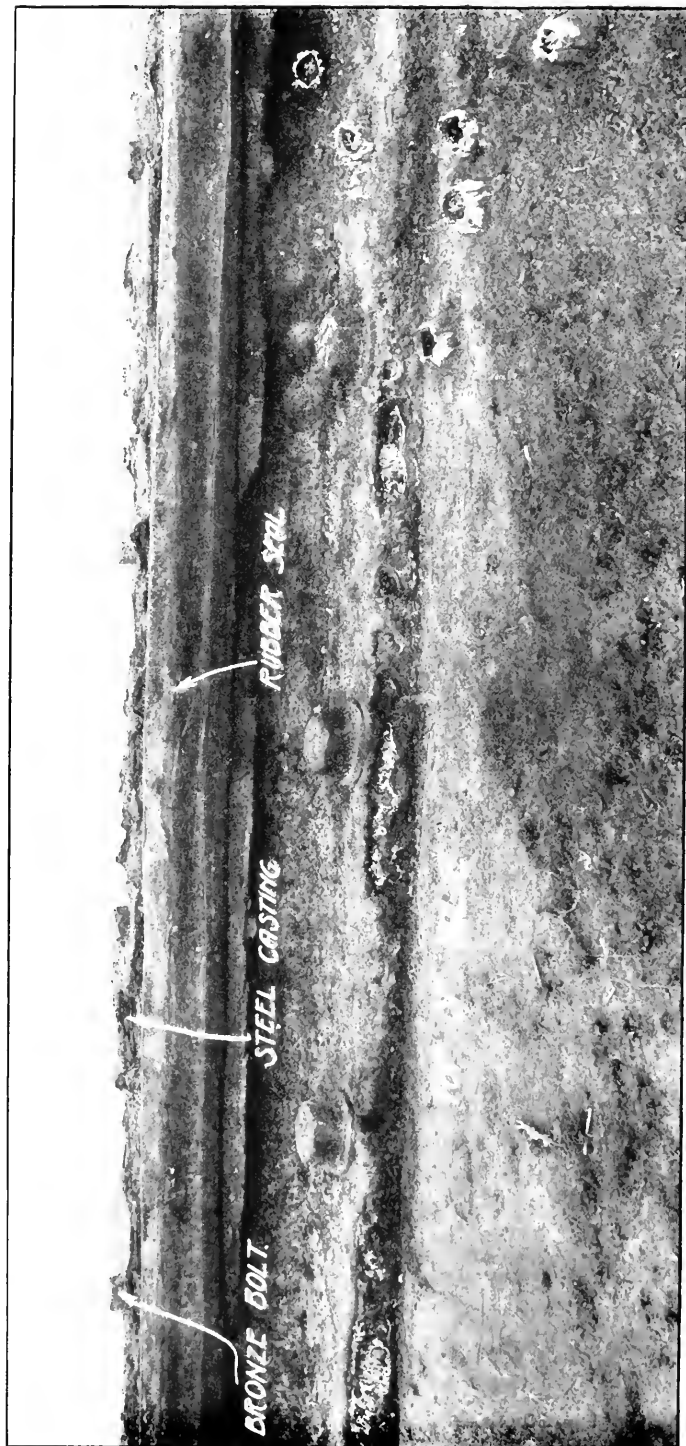
MIRAFLORES LOCKS, GATE NO. 116.



MIRAFLORES LOCKS. LOWER PANEL OF GATE NO. 116.



MIRAFLORES LOCKS, MARINE GROWTH ON GATE NO. 119.



MIRAFLORES LOCKS. TOP SEAL CASTING UPPER RISING STEM VALVE.



MIRAFLORES LOCKS. UPPER RISING STEM GATE VALVE.

THIS IS THE SURFACE  
UPON WHICH THE BRONZE  
SIDE SEAL RESTS )

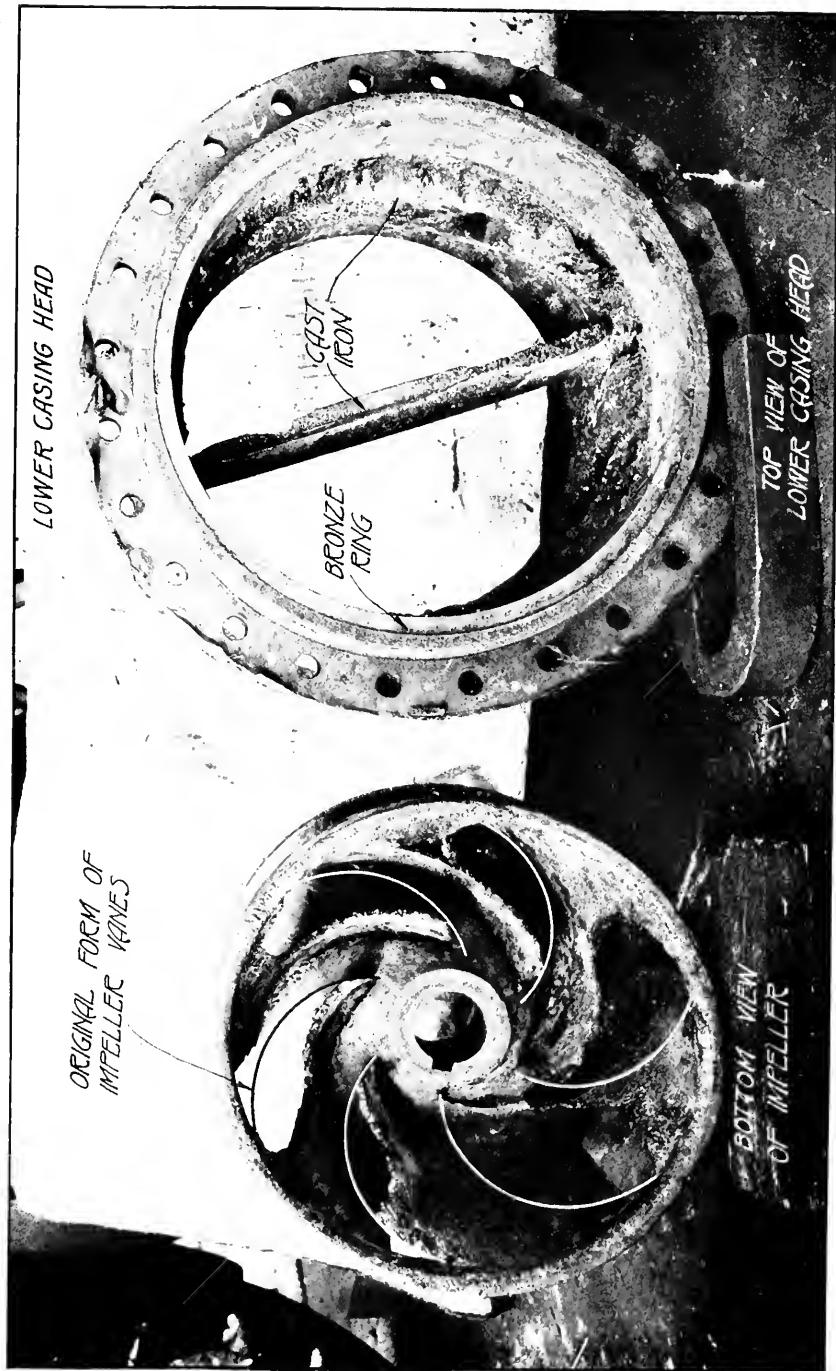


MIRAFLORES LOCKS. RISING STEM VALVE, REMOVABLE MACHINERY-STEEL SIDE SEAL STRIP.





GATUN LOCKS. ONE AND ONE-HALF INCH STEEL NUTS FROM CYLINDRICAL VALVE.

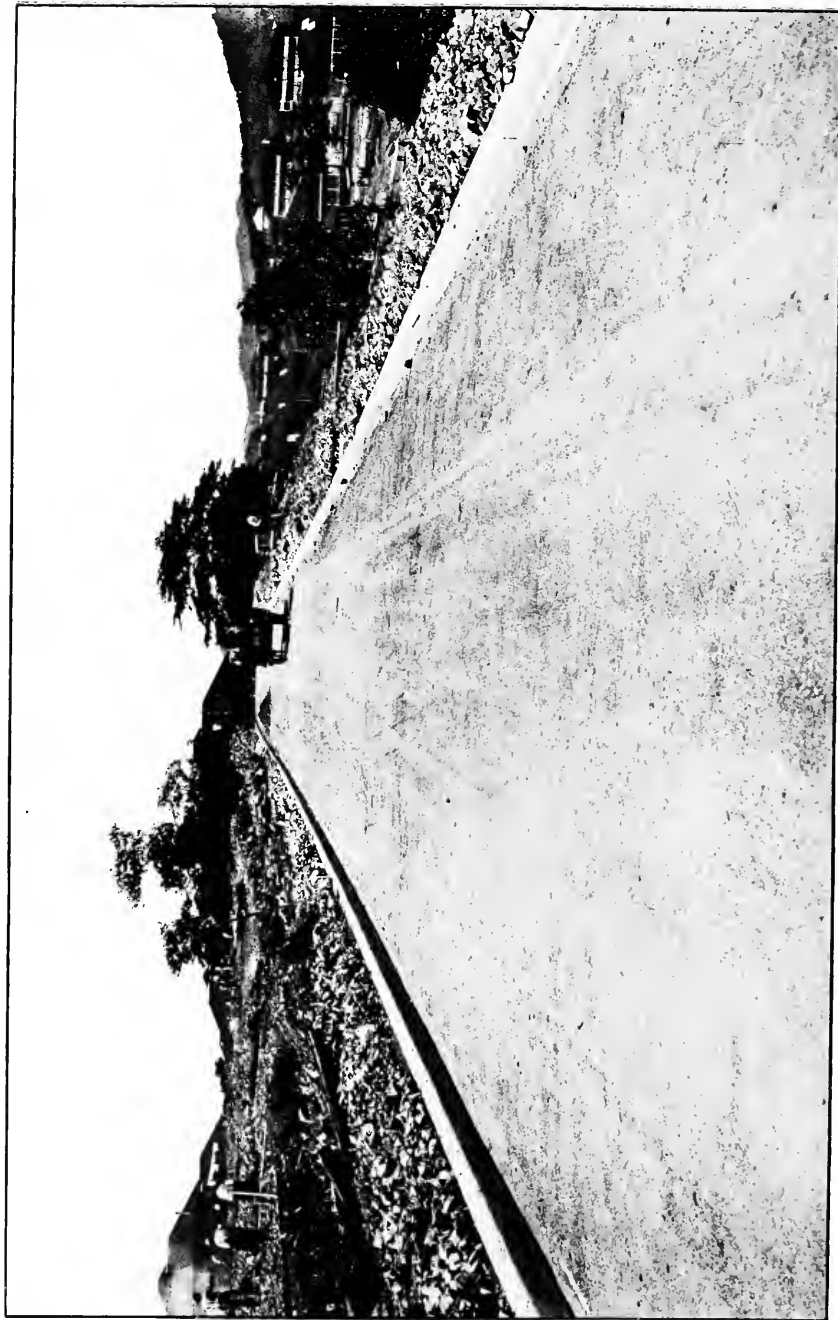


ELECTROLYTIC ACTION ON IMPELLER AND LOWER CASING HEAD OF ONE OF THE TWENTY-INCCH FLOATING CAISSON PUMPS.





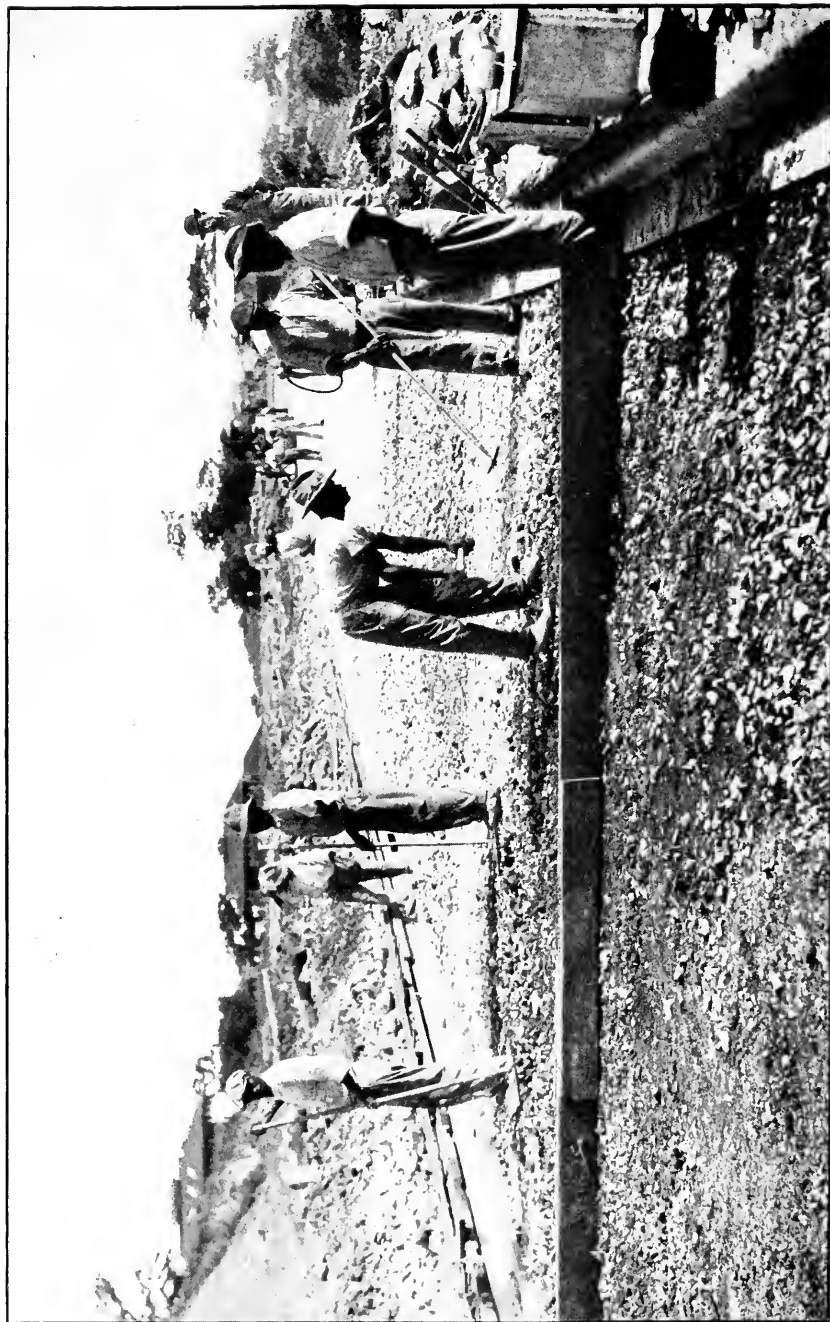
ELECTROLYTIC ACTION ON IMPELLER AND LOWER CASING HEAD OF ONE OF THE TWENTY-ONE INCH FLOATING CAISSON PUMPS.



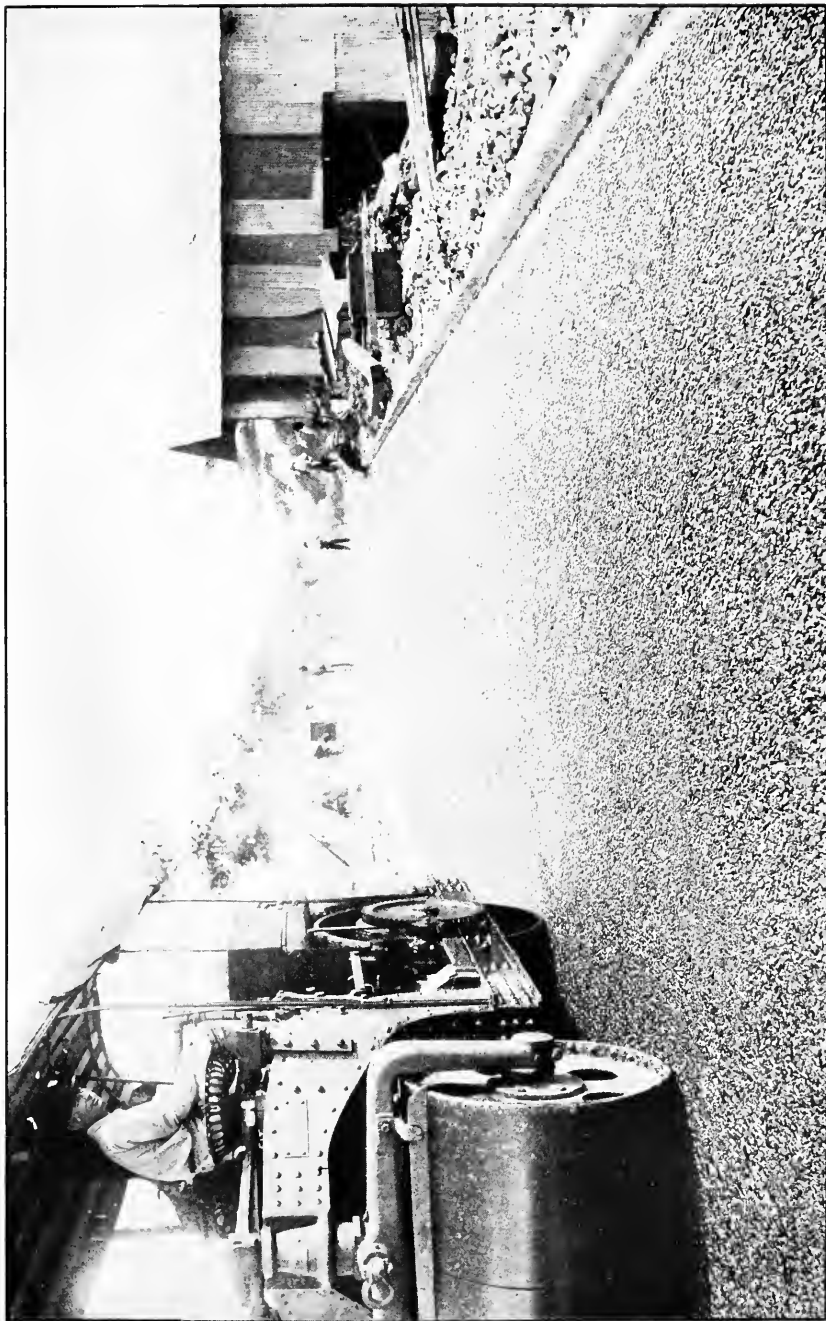
FINISHED ASPHALT STREET.



ROADBED AS PREPARED BEFORE APPLYING ASPHALT.



SHAPING OF ROADBED BEFORE FINAL ROLLING FOR ASPHALT COVERING.



ROADBED BEFORE SQUEEGEE COAT IS APPLIED.



## APPENDIX B.

### REPORT OF THE MARINE SUPERINTENDENT, MARINE DIVISION.

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BALBOA HEIGHTS, CANAL ZONE, *July 30, 1916.*

SIR: I have the honor to submit the following report of operations of the marine division for the fiscal year ended June 30, 1916:

#### ORGANIZATION.

Capt. Hugh Rodman, United States Navy, continued as marine superintendent until October 1, 1915, when he was succeeded by the undersigned who on September 1, 1915, had been appointed assistant to the marine superintendent.

On July 8, 1915, Lieut. P. P. Bassett, United States Navy, was appointed captain of the port, Cristobal, succeeding Commander D. E. Dismukes, United States Navy, relieved from duty with The Panama Canal.

On August 1, 1915, Lieut. A. B. Reed, United States Navy, was appointed captain of the port, Balboa, succeeding Commander H. V. Butler, United States Navy, during whose absence from the Isthmus Lieutenant Reed had from the beginning of the fiscal year been acting captain of the port.

Canal Pilot Fred Kariger remained throughout the year in charge of aids to navigation.

It was determined, after trial, that it would be to the best interests of the canal, as well as to shipping using the canal, to have pilots on the locks as lock pilots, and two pilots were accordingly sent to each set of locks to act as lock pilots under the direction of the lock superintendent. These pilots will be relieved by others from time to time, in order that all pilots may become qualified lock pilots as well as channel pilots.

Toward the close of the year the policy was adopted of employing on the gold roll white American citizens to displace the colored aliens in the positions of boatswain of tugs, foreman of docks, signal-station keeper, operator of motor boats, oiler, fireman, and seaman. The cooperation of the Navy Department was secured and that department nominates naval reserve men, retired enlisted men, or men honorably discharged from the Navy, to apply on our requisitions. While the salaries paid by the canal to these white Americans do not greatly exceed those paid to aliens in the same positions, in the cases of naval reserve and retired enlisted men their Navy pay added to their canal pay makes their positions attractive. It is believed that their services will prove incomparably better than those of the men they displace, and that the saving effected in wear and tear on the machinery and equipment of floating property in the hands of these

trained employees, together with the considerable numerical reduction which must result, will fully demonstrate the wisdom of the change.

Appropriation was made for the terminal office buildings recommended in last year's report, and during the year erection was in progress on a three-story concrete structure at each canal terminus for occupancy by the office forces of the captain of the port and those of other canal officials conjointly interested in shipping. At the close of the year the building at Balboa was practically completed, and the third floor assigned to the captain of the port. Construction of the Cristobal building was 32 per cent completed on June 30.

Branch hydrographic offices were maintained in connection with the captain of the port's office at either terminal.

Notices to mariners were issued from time to time concerning changes in aids to navigation and other matters of interest to navigators.

Two notices to steamship lines were issued; one advised that those lines whose vessels frequently transit the canal may make advance lump sum deposits covering tolls and other charges and keep open accounts with the canal, thus avoiding the inconvenience which theretofore resulted to owners and agents due to the requirement that deposit be made to cover charges on each individual vessel; the other defined the classes of vessels to which the canal obligates itself to supply coal at established rates.

Slides in Gaillard Cut interrupted traffic from September 1 until September 10, 1915, and from September 17, 1915, until April 15, 1916. During the latter tie-up the division's pay roll was largely reduced by temporarily transferring employees to the dredging division, where there was demand for their services, and by continuing them on leave without pay. Very few were discharged on account of suspension of traffic.

Cape Mala lighthouse was erected and put in commission on July 10, 1915. On June 26, 1916, a clapet carrying gas tanks and other material, with 27 persons on board, proceeded from Balboa for the purpose of replenishing the supply of gas and generally overhauling this lighthouse. A rough sea prevented the party from landing, occasioned the loss of considerable property by washing it overboard, and nearly resulted in the sinking of the clapet and the loss of the lives of all on board. Bona Island lighthouse was placed in commission on August 2, 1915; on November 25, 1915, it was struck by lightning, but was relighted the following day. On clear nights this light has been seen for a distance of 42 miles. The lighthouse on Taboguilla Island was placed in commission on August 10, 1915. The lights on Bona and Taboguilla Islands were unwatched and burned incessantly, except for the brief interruption noted in the case of the former. All three lights proved satisfactory and economical.

Slight changes were made in the aids to navigation and in the characteristics of lights, as experience and local conditions seemed to dictate, in order to better facilitate the transit of shipping, both by day and by night.

The signal stations at Gamboa and La Pita were maintained. A new signal station was erected on Sosa Hill. This station commands a splendid view of Balboa Harbor and enables the captain of the port



to communicate with ships much more expeditiously than was possible before.

The mooring stations at Gamboa and Empire were maintained throughout the year. The former station is permanent; its mooring buoys were renewed and heavier moorings laid. It was found desirable to establish another temporary mooring station near Paraiso; this will probably be maintained until the channel past the slides is in such shape that vessels can safely transit Gaillard Cut without delay.

The absence of a bad sea or swell in the harbor of Cristobal has been noticeable since the practical completion of the east breakwater, and it is evident that the entire harbor will be protected for shipping in all weathers.

In addition to handling ships' business, the radio stations at the terminal ports sent out daily news bulletins, time signals, and notices to mariners of interest to approaching vessels.

One 50-foot motor boat and three launches of the *Pilot* type were purchased and put in use. The launch *Aspinwall*, formerly used as a supply and passenger boat in connection with the operation of the hotel of its name on Taboga Island, was transferred to the marine division. The launch *Q* was condemned, her hull destroyed, and her engine retained as a spare.

Until the slides have been removed and there is reasonable certainty that all ships can be transited promptly, the large two-story building erected on the quarantine reservation at Balboa will not be needed for occupancy by pilots, and it was therefore temporarily transferred to the supply department for rental.

The confusion attending the levying of tolls still continues, as, under the interpretation of the Attorney General noted in the last annual report, it is necessary to consider two factors, United States net registered tonnage and Panama Canal net tonnage, in arriving at the amount of tolls to be assessed. This, of course, will continue until Congress remedies the situation by legislation authorizing the application of the Panama Canal rules of measurement alone in all cases.

The following statistics of traffic through the canal are presented:

TABLE No. 1.—Summary of traffic through The Panama Canal since its opening to commercial traffic.

Month and year.	Atlantic to Pacific.			Pacific to Atlantic.			Total.		
	Ves- sels.	Canal tons.		Cargo tons.	Ves- sels.	Canal tons.		Cargo tons.	
		Gross.	Net.			Gross.	Net.		
1914.									
August.....	13	58,233	41,931	49,106	11	62,049	44,017	62,178	
September....	27	151,878	109,684	141,762	30	151,568	131,375	180,276	
October.....	44	210,925	174,472	108,069	40	220,179	153,744	253,288	
November.....	54	247,479	172,825	206,510	38	205,071	149,906	242,201	
December.....	43	204,776	145,676	179,235	27	280,896	198,618	271,219	
1915.									
January.....	44	239,486	169,228	208,082	54	251,085	177,984	240,925	
February.....	38	209,822	147,359	150,987	53	245,522	175,523	276,078	
March.....	57	269,901	187,568	217,447	80	405,380	288,416	417,610	
April.....	59	279,139	199,213	237,384	60	290,738	205,326	285,457	
May.....	67	343,701	240,698	246,534	75	390,104	232,252	332,174	
June.....	83	412,525	296,694	320,619	60	286,330	201,116	282,561	
July.....	93	463,726	297,329	316,773	77	356,145	250,041	388,696	
August.....	89	416,465	288,194	249,194	72	333,298	236,857	236,218	
September....	29	235,397	166,751	181,380	51	333,004	178,619	274,937	
October.....									
November.....	3	1,548	851	671	6	12,446	8,957	12,908	
December.....									
1916.									
January.....	4	694	694	1,100	2	814	600	814	
February.....	2	387	203		5	2,685	1,790	3,379	
March.....	32	142,642	102,378	144,133	18	18,407	11,605	18,794	
April.....	39	311,851	215,473	248,289	60	237,157	140,306	224,620	
May.....	70	338,108	236,358	292,771	48	257,157	179,070	245,861	
June.....					54	231,174	163,686	225,020	
Total.....	941	4,570,711	3,192,959	3,559,971	934	4,442,605	3,129,838	4,549,867	
					1,875	9,013,316	6,322,797	8,109,838	

TABLE NO. 2.—*Number of vessels of various nationalities passing through The Panama Canal.*

## ATLANTIC TO PACIFIC.

Month.	American.	British.	Chilean.	Danish.	Dutch.	French.	Honduran.	Italian.	Japanese.	Nicaraguan.	Norwegian.	Panamanian.	Peruvian.	Russian.	Swedish.	Total.
1915.																
July.....	33	41	2	3	1	.....	.....	1	6	.....	2	.....	2	.....	3	93
August.....	23	42	4	1	3	.....	.....	.....	2	.....	6	4	3	.....	.....	89
September.....	10	27	1	.....	3	.....	1	.....	1	.....	2	1	1	.....	2	49
October <sup>1</sup> .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
November <sup>1</sup> .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
December <sup>2</sup> .....	2	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
1916.																
January <sup>1</sup> .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
February <sup>2</sup> .....	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
March <sup>2</sup> .....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	2
April.....	12	13	1	2	.....	.....	.....	.....	3	.....	.....	.....	1	.....	.....	32
May.....	13	36	4	.....	1	.....	.....	.....	4	.....	5	.....	5	1	.....	69
June.....	16	33	4	4	3	.....	.....	.....	3	.....	4	.....	3	.....	.....	70
Total, fiscal year 1916.....	114	193	16	10	11	.....	1	1	19	.....	19	6	15	1	5	411
Total, fiscal year 1915.....	233	225	16	11	5	2	2	1	4	1	16	.....	2	5	7	530

## PACIFIC TO ATLANTIC.

1915.																
July.....	22	35	2	2	.....	1	2	.....	1	.....	5	.....	1	.....	5	77
August.....	29	34	3	1	.....	.....	.....	.....	.....	2	2	.....	2	.....	1	72
September.....	15	22	1	4	1	.....	.....	.....	1	.....	5	.....	1	.....	1	51
October <sup>1</sup> .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
November <sup>1</sup> .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
December <sup>2</sup> .....	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	6
1916.																
January.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	2
February.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
March.....	3	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
April.....	19	17	1	1	2	.....	.....	.....	1	.....	5	.....	2	.....	.....	48
May.....	14	29	5	.....	1	.....	.....	.....	1	.....	4	.....	5	.....	1	60
June.....	15	26	5	.....	.....	.....	.....	.....	1	.....	4	.....	3	.....	.....	54
Total, fiscal year 1916.....	124	165	17	8	4	1	2	.....	5	.....	26	1	14	.....	8	*376
Total, fiscal year 1915.....	238	239	19	13	2	1	1	1	2	1	25	2	2	1	11	558
Grand total, fiscal year 1916.....	238	358	33	18	15	1	3	2	24	.....	45	7	29	1	13	787
Grand total, fiscal year 1915.....	471	464	35	24	7	3	3	2	6	2	41	2	4	6	18	1,088
Total number of vessels to July 1, 1916.....	709	822	68	42	22	4	6	4	30	2	86	9	33	7	31	1,875

<sup>1</sup> Canal not in operation.<sup>2</sup> Traffic interrupted by slides.

\* Including 1 Argentinian vessel.

TABLE No. 3.—*Distribution of traffic through The Panama Canal, fiscal year 1916.*

## ATLANTIC TO PACIFIC.

Month.	United States coastwise.			United States to South and Central America.			United States to Far East and Australasia.			Atlantic terminals to South and Central America.			Europe to west coast of South America.			Europe to west coast of North America.			Miscellaneous.			Ballast.			Total.	
	Vessels.	Canal net tons.	Cargo tons.	Vessels.	Canal net tons.	Cargo tons.	Vessels.	Canal net tons.	Cargo tons.	Vessels.	Canal net tons.	Cargo tons.	Vessels.	Canal net tons.	Cargo tons.	Vessels.	Canal net tons.	Cargo tons.	Vessels.	Canal net tons.	Cargo tons.	Vessels.	Canal net tons.	Cargo tons.	Net tons.	Cargo tons.
1915.																										
July.....	20	66,839	74,170	11	33,893	32,508	24	110,535	174,574	10	13,864	9,816	4	12,921	11,155	5	19,089	9,585	1	3,067	4,965	18	37,120	93	297,328	316,773
August.....	13	51,876	67,102	9	28,740	36,431	16	67,286	103,745	13	24,737	14,310	2	9,097	4,728	5	20,362	8,853	2	7,255	13,950	29	78,841	89	288,194	249,119
September.....	10	39,923	42,357	6	21,192	36,327	12	49,632	88,534	5	7,560	4,702				4	14,149	9,460	1	3,122		11	31,173	49	166,751	181,380
October.....																										
November.....																										
December.....																										
1916.																										
January.....																										
February.....																										
March.....																										
April.....	2	5,452	8,164	6	18,223	28,323	12	50,699	82,328	5	10,470	5,975				2	6,202	7,773	4	6,951	11,570	1	33	2	102,378	144,133
May.....	3	8,243	16,502	12	35,530	58,341	15	64,462	108,629	16	28,767	15,322	5	14,820	19,773	2	5,253	6,184	3	14,876	23,535	13	43,322	69	213,473	248,289
June.....	2	11,039	18,895	12	43,016	73,729	20	94,719	149,089	19	33,126	23,455	3	8,988	9,414	2	5,883	9,790	1	4,869	8,492	11	32,718	70	236,558	292,771
Total.....	50	183,372	227,103	56	180,594	265,659	99	437,333	706,896	73	121,845	75,351	14	45,826	45,070	20	70,938	51,645	14	40,456	62,512	85	227,866	411	1,308,230	1,434,226
Fiscal year 1915.....	172	689,790	951,044	79	258,951	294,510	102	413,691	627,517				52	124,696	65,299	31	105,264	99,478	19	61,217	87,887	75	231,119	530	1,884,728	2,125,735

## PACIFIC TO ATLANTIC.

Month.	United States coastwise.			South and Central America to United States.			Far East and Australasia to United States.			South and Central America to Atlantic terminus.			West coast South America to Europe.			West coast North America to Europe.			Miscellaneous.			Ballast.			Total.
	Vessels.	Canal net.	Cargo tons.	Vessels.	Canal net.	Cargo tons.	Vessels.	Canal net.	Cargo tons.	Vessels.	Canal net.	Cargo tons.	Vessels.	Canal net.	Cargo tons.	Vessels.	Canal net.	Cargo tons.	Vessels.	Canal net.	Cargo tons.	Vessels.	Canal net.	Cargo tons.	
July.....	11	52,372	73,321	25	74,691	110,099	517,745	29,381	8,396	14	51,660	108,010	8	28,379	42,049	5	22,161	17,470	1	1	22	77	250,041	388,696	
August.....	15	61,858	83,643	23	77,673	139,738	520,496	32,798	14,458	7	24,341	40,121	3	9,806	14,490	1	441	1,000	1	5	20,675	72	236,857	326,218	
September..	10	38,600	49,251	9	31,727	60,128	621,971	40,921	7,873	9	31,309	46,474	9	32,517	50,087	2	9,697	19,063	51	178,619	271,937	51	178,619	271,937	
October.....																									
November..																									
December..	1	1,792	2,656																						
January.....							1	388	550																
February....																									
March.....	2	8,283	3,000	1	3,197	4,000																			
April.....	2	4,689	5,414	20	73,020	134,531																			
May.....				16	62,392	116,801	1	2,302	4	22	41,127	35,012	5	17,619	28,929	4	20,623	20,282	5	10,310	60	179,070	215,861		
June.....				21	77,519	143,732	210,234	5,559	28,528	5	17,135	27,521	1	3,642	6,596	4	212,109	13,064	4	6,767	54	163,686	225,020		
Totals	41	167,594	217,285	115	400,219	709,049	20,76,136	109,213		48	173,732	309,436	34	113,957	178,807	15	56,069	72,109	35	46,048	376	1,171,531	1,705,810		
Fiscal year, 1915.....	163	615,501	805,614	127	448,512	653,361	16,74,826	98,195		103	303,528	438,373	111	422,815	735,421	818	1,58	23,093	30	74,967	558	1,958,307	2,844,057		

## MEASUREMENT OF VESSELS AND APPLICATION OF TOLLS.

The board of admeasurers continued its operations in the same manner as throughout the previous fiscal year. This board consists of the marine superintendent and the captains of the ports at Cristobal and Balboa.

Certificates of measurement, purporting to be in accordance with the Panama Canal or the United States rules for measurements, presented by vessels when applying for transit, are examined and on inspection of the vessel are, if necessary, made to conform to their respective regulations in effect at the time.

The requirement that the United States net registered tonnage be considered in the assessment of tolls added greatly to the work of the board, especially because of numerous changes during the year in interpretations placed upon the United States rules for measurement by the Commissioner of Navigation of the United States Department of Commerce. Considering the United States rules for measurement as a factor in the levying of tolls has resulted in exempting practically all shelter-deck spaces and deck loads of vessels transiting the canal, which in turn has resulted in discrimination against most of the United States vessels transiting the canal during the year, owing to the fact that almost all United States vessels are so constructed that they are unable to take advantage of shelter-deck space. On the other hand, the United States rules provide for the exemption of certain cabin spaces above the upper deck that is not a deck attached to the hull, which would in most cases result in discrimination against foreign vessels in favor of United States passenger steamers if the national register of the vessel were recognized as a factor to be considered in the levying of tolls. In order that our treaty obligations may be lived up to and that discrimination may be avoided, and in accordance with the Attorney General's decision that the United States net registered tonnage shall be considered as a factor in the levying of tolls, the board of admeasurers has adopted the rule that in the case of all foreign vessels the United States rules for measurement will be applied in order to find an equivalent United States tonnage to be considered as the second factor in determining the amount of tolls to be assessed.

As time goes on and traffic increases, with a resulting increase in the number of classes of vessels using the canal, it becomes more evident that it will be absolutely necessary to adopt some one rule for the levying of tolls, and experience has demonstrated beyond a doubt that the fairest rules for determining the tonnage of a vessel, in order that tolls may be assessed without discrimination and on a just basis, are the Panama Canal rules for measurement. It is again recommended that legislation be secured authorizing the levying of tolls on the basis of the Panama Canal rules alone. We collected in tolls during the year \$2,399,830.42, but had we been permitted to consider only the Panama Canal rules for measurement the revenue from this item would have been \$2,790,544.47, showing a direct loss in revenue on this account of \$390,714.05.

## STEAMBOAT-INSPECTION SERVICE.

Upon the detachment from the canal service of Commander D. E. Dismukes, United States Navy, Lieut. P. P. Bassett, United States Navy, was, on July 8, 1915, appointed chairman of the board of local

inspectors. On August 1, 1915, Lieut. A. B. Reed, United States Navy, was appointed a member of the board, taking the place of Commander H. V. Butler, United States Navy, who was detached from service at the canal and whose place on the board Lieut. Reed had been occupying by temporary appointment since June 28, 1915.

Upon the board's recommendation, Circular 705 was issued on October 30, 1915, providing that no lighter equipped with steam power, either for propulsion or for handling cargo or coal, shall be used alongside any ship whose cargo contains explosives or inflammable products.

On November 1, 1915, Circular 603-10, reading as follows, was issued:

1. On the recommendation of the Board of Local Inspectors, approved by the Marine Superintendent, all of Circular No. 606-3, dated May 8, 1914, and paragraph 133 of Circular No. 644, dated May 1, 1914, concerning positions on dipper dredges in the service of The Panama Canal, are revoked effective October 30, 1915.
2. All of Circular No. 605-1, dated November 9, 1914, concerning seniority of dipper dredge men, is also revoked effective October 30, 1915.

On the board's recommendation, Circular No. 644-3 was issued on December 14, 1915, providing that—

Upon the application of any master or owner of any steam vessel employed in the carriage of passengers for a license to carry gunpowder, the local inspectors shall examine such vessel, and if they find that she is provided with a chest or safe composed of metal, or entirely lined and sheathed therewith, or if the vessel has one or more compartments thoroughly lined and sheathed with metal, at a secure distance from any fire, they may grant a certificate to that effect, authorizing such vessel to carry as freight within such chest, safes or compartments, the article of gunpowder, which certificate shall be kept conspicuously posted on board such vessel.

All accidents resulting in damage to shipping in Canal Zone waters were investigated by the board of local inspectors, which, wherever possible, fixed the responsibility for the damage and estimated the cost of repairs.

Further details concerning steamboat inspection and licenses are contained in the following extracts from the report of the board of local inspectors:

On November 5, 1915, the board adopted and the Governor approved a new form of certificate which is being issued to all foreign passenger steamers which pass inspection here. The form of certificate theretofore issued to all passenger steamers passing inspection here is now being issued only to passenger steamers flying the American flag; when the present supply of this form is exhausted there will be adopted and issued in its stead a form of certificate corresponding in size to the certificates now issued by this board to foreign passenger steamers, and made to otherwise conform to certificates issued by the Steamboat Inspection Service of the United States Department of Commerce.

On January 1, 1916, the board opened a new register of steamship inspections for American steamers, and a similar register for foreign steamers, each showing on a single line the date certificate issued, number of certificate, name of ship, owner or agent, tonnage, date certificate expires, date authority for issuance received, port from which the vessel hails, date certificate delivered to the collector, date and number of the renewing certificate, and any pertinent remarks. These registers are believed to be a great improvement over the record of inspections theretofore kept.

Prior to December of 1915 there were known to be many motor boats in Canal Zone waters of which the board had no proper record. During that month the division of police completed a census of motor boats in Zone waters, and with that census as a basis the board opened and is maintaining a new register of inspection very similar to its registers of steamship inspections.

Prior to November 1, 1915, it was the practice of this office to make and deliver certified copies of inspection certificates, and to collect and transmit the fees to the collector. Since that date a strict compliance has been made with the provisions of Circular 644 requiring this office to transmit to the collector the original only of each certificate, he to make and deliver the certified copies and to receive the fees direct.

A semiannual inspection of the floating equipment of the canal and railroad, excluding the equipment of the dredging division in Gaillard Cut (which exclusion was approved by the Acting Governor), was made and report of same submitted under date of January 7, 1916. This report and the notes amending it submitted under date of February 25, 1916, were approved and the heads of the divisions interested notified to make their floating equipment conform thereto.

Inspections were made and certificates of seaworthiness issued to 4 American steamers and 23 foreign steamers.

From January 1 the date of opening our present register inspections were made and certificates of seaworthiness issued to 27 motor boats of The Panama Canal and 32 privately owned motor boats.

On February 10, 1916, the practice of inspecting and issuing certificates of seaworthiness to Army and Navy launches, and other public vessels of the United States other than those of The Panama Canal was discontinued.

Inspections and tests were made of 81 boilers on floating equipment of The Panama Canal and Panama Railroad Co., and the heads of divisions interested were furnished reports and certificates thereof.

From time to time the board made appraisals of floating equipment for sale or transfer, as requested by the surveying officer or directed by the Governor.

In order that the canal might secure the highest possible class of employees to operate its new 15-yard dipper dredges, the board decided to call before it for examination the canal dredgemen, and to indorse good for the 15-yard service licenses of those who satisfied the board of their qualifications for such service. The board then recalled for classification as 5-yard dipper dredge licenses all dipper dredge licenses other than those for 15-yard dipper dredges.

The board considered the request of the Commanding General of the United States troops on the Canal Zone that authority be given him to appoint chauffeurs for the military service on the Isthmus without examination by the local board, and decided that, in order to make the practice uniform, authority to operate an automobile over the streets and roads of the Canal Zone would be given only after the applicant had passed an examination prescribed by the board.

On December 1, 1915, all navigator's and chauffeur's licenses which had been signed by Capt. Bodman as marine superintendent and by Commander Dismukes as chairman, but never issued, were returned to the auditor for cancellation.

The board decided that, in event the loss of a chauffeur's or navigator's badge be made known to it, notification would be at once sent to the Zone police authorities, and if at the expiration of 30 days after such notification the badge had not been returned to the board a new license and badge would be issued upon payment of the required fee. It was also decided that in case of a chauffeur's or navigator's license becoming worthless because the writing on its face is no longer legible, the recorder shall, upon application, certify that such license was issued.

The board considered the advisability of limiting licenses to motor-boat operators based on the horsepower of the engine, and decided that an applicant who demonstrates his ability to handle a boat equipped with an outboard motor or small gasoline engine, but who is not believed fit to be intrusted with a license to operate motor boats up to 15 tons, shall receive a license to operate motor boats equipped with motors not to exceed 3 horsepower.

In order that a more certain means of identification of Canal Zone chauffeurs and navigators might be had, and to prevent the frequent annoyance and fraud resulting from sale and renting of badges, and their loss and subsequent use by those not entitled to use them, the board recommended the discontinuance of the issuance of such metal badges, and the issuance in lieu of the present license forms of small cards bearing the signature, photograph, age, and description of the licensee, the number of the license, the signature of the marine superintendent, and the seal of the board applied partly over the face of the photograph.

The activities of the board of local inspectors are increasing as traffic through the canal develops, for, in addition to its duty of inspecting shipping in Canal Zone waters, it is required to place responsibility for all serious accidents to shipping transiting the canal.

Respectfully,

H. I. CONE,  
*Marine Superintendent.*

Maj. Gen. GEO. W. GOETHALS, *United States Army,*  
*Governor, The Panama Canal, Balboa Heights, Canal Zone.*



## APPENDIX C.

### REPORT OF THE ENGINEER OF TERMINAL CONSTRUCTION, DEPARTMENT OF OPERATION AND MAINTENANCE.

BALBOA HEIGHTS, CANAL ZONE,  
*May 31, 1916.*

SIR: I have the honor to submit the following report of work performed by the division of terminal construction during 11 months of the fiscal year 1915-16, viz, from July 1, 1915, to May 31, 1916, when the state of completion of terminal work rendered the existence of a separate organization no longer necessary, and the division was formally abolished.

#### ORGANIZATION.

The work has been executed by the following organization:

(1) A designing and office engineering force at Balboa Heights that has handled all office work connected with the design, preparation of plans and specifications, engineering correspondence and office work connected with the coaling plants, dry dock, floating cranes, and for the wharves and pier at Balboa.

The junior engineer in charge of the inspection of the manufacture of concrete blocks by contract at Gamboa has also been attached to this office.

(2) The Pacific terminals construction subdivision, charged with all construction work at Balboa connected with the shops, dry dock, coaling plant, wharves, and pier, Sosa Hill rock excavation, and field inspection of work performed by contractors, and by Panama Canal forces pertaining thereto.

(3) A subdivision charged with the construction of the Cristobal coaling plant, Atlantic terminals, and the inspection of contract work pertaining thereto.

(4) A subdivision charged with the construction of the east breakwater, Atlantic terminals.

(5) A subdivision charged with the design and construction by the Panama Railroad Company of Pier No. 7, Atlantic terminals, also reported to the engineer of terminal construction on engineering matters.

The following changes in organization have occurred:

The two floating cranes having been completed and accepted by The Panama Canal the services of Assistant Engineer Henry Schoellhorn, who acted as inspector for The Panama Canal on the construction of these cranes, were terminated, and he left the Isthmus on November 30, 1915.

Effective at the close of business April 30, 1916, the Pacific terminals subdivision was abolished, and during the month of May the uncompleted work was continued by a skeleton organization with various subheads reporting directly to the engineer of terminal construction.

Effective at the close of business May 10, 1916, the force engaged on the office design and engineering work on the pier and certain of the wharves at Balboa under Assistant Engineer Walter Rowland was disbanded on account of completion of work.

Effective at the close of business May 31, 1916, the division of terminal construction was abolished, and arrangements were made to have items of uncompleted work carried to final termination either by other divisions on work requests or by the existing organizations under the engineer of maintenance.

#### DESIGN AND OFFICE ENGINEERING.

##### COALING PLANTS, DRY DOCK, AND FLOATING CRANES.

Designing, including handling of engineering correspondence, and matters connected with the inspection of contract work in connection with the dry dock, coaling plants, and floating cranes, has continued under the immediate supervision of Civil Engineer F. H. Cooke, United States Navy, as designing engineer.

##### COALING PLANTS.

The annual reports for 1914 and 1915 gave the dimensions and capacities of the coaling plants at Cristobal and Balboa, and the characteristics and prices of the coal-handling machinery and accessories being supplied at each plant under contracts with Augustus Smith and the Hunt Construction Co., Washington Orders 40483 and 40587, respectively. No modifications have been made since last year except in a few unimportant details.

Supplemental contracts aggregating \$5,140 were entered into with the Hunt Construction Co. as additions to the original contract, Washington Order No. 40587, for the addition of two loading-out chutes for each of the unloaders, of which there are four at the Cristobal plant and two at the Balboa plant. These loading-out chutes have been added in order that the unloaders may, if required, be used for loading barges placed in front of them, reclaiming by means of their shore booms and delivering coal to such barges via the 50-ton hopper, the aforesaid loading-out chutes, which are built into the tower, and portable chutes suspended below and in front of the loading-out chutes.

The unloaders at the Cristobal coaling plant were subjected to the acceptance tests required by the contract in February and March, 1916. As the result of conditions that developed during these tests, the contractor is making certain modifications and adjustments in the unloaders to enable them to fully meet the contract requirements, and to date the Cristobal unloaders have not been accepted by The Panama Canal.

The coal-handling machinery and accessories being furnished under Washington Order No. 40483 by Augustus Smith at the Cristobal coaling plant is nearing completion, and will probably be ready for the acceptance tests required by the contract by the beginning of next fiscal year.

None of the coal-handling machinery and accessories at the Balboa coaling plant has yet been subjected to the acceptance tests. The readiness of the two unloaders under Washington Order No. 40587 is

dependent on the completion of modifications rendered necessary by conditions that developed during the Cristobal tests above referred to, while the equipment being furnished under Washington Order No. 40483 will not be ready for acceptance tests before October, 1916.

At the close of last fiscal year working drawings had been issued for all of the substructure at the Cristobal plant except a small portion of the deck slab of the end wharf and the partition walls. These drawings were completed and issued early in the present fiscal year, and the drafting force engaged on this work was disbanded. Since then a few additional drawings have been made and issued, principally for the concrete floors and walls of the wharf bunker. The concrete partition walls for the dry-storage area will not be built until required by lessees of areas therein. These walls will be cast in sections 15 feet long by 13 feet high, so that they may be moved from place to place within the plant as required.

For the Balboa coaling plant, at the close of last fiscal year, all of the construction drawings had been issued for the berm crane supports and adjacent retaining walls, and for the modification of the berm cranes, except for a few minor details. The drawings for the modifications of the berm cranes were completed during the present fiscal year, as were practically all other construction drawings necessary, the last item to be completed being the construction drawings for the support of the conveying system between the coal-storage area and the reloader wharf, a locality consisting largely of filled ground requiring pile foundations.

Assistant Engineer Carl Mönniche, who had been engaged on the design of the Cristobal coaling plant, resigned on July 8, 1915.

Owing to the reasonable selling price of coal on the Isthmus, and the existing high freight rates, no desire has been evinced by private coal companies to lease any of the areas in the dry-storage piles, which have been tentatively assigned for that purpose.

#### DRY DOCK NO. 1.

Assistant Engineer A. R. Brown has continued in immediate charge of designing and the preparation of masonry plans in connection with Dry Dock No. 1 and the entrance pier.

The last annual report gave the principal dimensions and described the construction of Dry Dock No. 1, including the means adopted for flooding and pumping out the dock, and stated that contracts for the pumping plant and for the flooding and sluice valves for controlling the flow of water had been entered into toward the end of the fiscal year 1915. The award of these contracts enabled work to proceed on the construction drawings for the pump pit and the housing for the pumping plant and adjacent air compressor plant, and for the flooding and sluice valves and accessories.

At the close of last year, construction drawings had been issued for the greater part of the dry-dock masonry, but a considerable amount of work remained to be done in the detailed development of the piping systems, duct lines, surface-drainage systems, blocking system, emplacement and protection of machinery for operating the miter gate, capstans and bollards, handrails, and miscellaneous fittings and accessories.

*Air, water, and electric outlets into the dock.*—The dock is encircled by electric duct lines and by compressed air and water piping. Air, water, and electric outlets are provided at the edge of the coping, and outlets for air and water in the base of the side walls just above the dock floor. These outlets are as follows for each side of the dock:

At the coping level, 6 compressed air, 7 fresh water, and 4 electric.

At the floor level, 6 compressed air, and 7 fresh water.

Provision has been made whereby a salt-water pumping plant with an individual salt-water piping system can be conveniently added in the future if experience indicates that the initial cost and operating expense would be justified.

*Chain handrails.*—Extending completely around the coping and across the miter gate is a chain and stanchion handrail. The stanchions are removable and are set in bronze sockets fixed in the masonry. The stanchions are galvanized steel, each provided with two eyes through which pass the two chains which constitute the handrail. The upper chain is 3 feet above the coping and the lower chain is 1 foot 6 inches above the coping. The chain is made up of standard close links of five-sixteenths of an inch stock, galvanized, and each length of chain is provided with a turnbuckle and pull-up hook so that the chains can be easily slacked off when desired. Altogether, there are about 3,000 linear feet of handrail, including about 425 linear feet around the coping of Dry Dock No. 2. The individual chains average 60 feet in length, and the stanchions are spaced about 7 feet 6 inches centers. The total cost of the material, which was purchased under Requisition No. 2513-R, was \$5,763.80.

*Blocking system.*—The blocking system adopted consists of a row of cast-iron keel blocks on the longitudinal center line of the dock; provision for two rows of timber docking keel blocks on each side of the center line; and a system of sliding bilge blocks at 12 feet centers.

The blocks are nominally 4 feet 6 inches high, and both the cast iron and timber blocks are 14 feet thick.

The general layout of the blocking system is shown on Plate No. 86. The range of fixed keel blocks now to be installed is 916 feet, the blocks being permanently fixed to the dock floor, 4 feet center to center, throughout this length. Sufficient blocks are being purchased to enable intermediate portable blocks to be set to give a 2-foot spacing for a total length of 600 feet, the idea being to set these intermediate blocks, which are identical with the fixed blocks, where the closer spacing is required by the weight of vessel docked, for example, under the turrets of a battleship.

Mention has been made above of two rows of docking keel blocks on each side of the center lines; these are known as the "narrow" range and "wide" range, respectively. The "wide" range has been provided to take care of vessels of great beam, such as the latest types of battleships. The "narrow" range covers a length of 850 feet of dock floor, and the blocks can be set so as to bring their inner top ends 6 feet from the center line of the dock, their outer top ends 31 feet 9 inches from the center line of the dock, or in any position intermediate between these two extremes. The "wide" range covers a length of 636 feet of dock floor, and the top outer ends of the blocks can be set 46 feet from the center line of the dock.

The sliding bilge blocks cover a length of 528 feet of dock floor. The slides are at 12 feet centers, and the docking keel blocks are at 4 feet centers, hence every third sliding bilge block coincides with a docking keel block, and the lower structure of the sliding bilge block will be used as a docking keel block when not required as a sliding bilge block. The inner ends of the sliding bilge blocks can be set anywhere between the extremes of 7 feet 3 inches and 42 feet 3 inches from the center line of the dock, the range thus being 35 feet.

The cast-iron keel blocks are detailed on Plate No. 83. Each block consists of the following four pieces:

A bottom section weighing 1,380 pounds.

Two "wedge" sections weighing 950 pounds each, and

A top section weighing 994 pounds.

Thus the total estimated cast-iron weight of each assembled block is 4,274 pounds. The sections are each 4 feet long, and when assembled from a pile 3 feet 4 inches high, the remainder of the normal 4 feet 6 inches height being made up of a 10-inch by 14-inch timber cap and a 4-inch by 14-inch timber cushion piece. This timber is white oak. The wedges have a taper of three-fourths of an inch in 12 inches, and since two wedge pieces are provided, the block may be "taken down" by driving out either wedge. The top of the top block, the bottom of the bottom block, and contact surfaces between individual blocks, are the only portions which are machined. The thickness of metal is generally  $1\frac{3}{4}$  inches, the base of the bottom block being  $2\frac{1}{4}$  inches thick. Contract was let to the Kilby Locomotive & Machine Works, of Anniston, Ala., for 381 of these blocks at a unit cost of \$87.62, which figures slightly more than 2 cents per pound. Only 380 blocks are needed for the dock; the remaining block was purchased in order that its strength might be tested by loading it to destruction.

A complete keel block was selected at random from the first sets of blocks completed and shipped to the Pittsburgh laboratory of the Bureau of Standards, for test in the 10,000,000-pound capacity testing machine in that laboratory. These tests were made in February, 1916, and were very successful. The maximum load which the keel blocks may be expected to bear in service is about 300,000 pounds, but the sample block when loaded for the full 4-foot length of the top block withstood without failure the maximum load of 10,000,000 pounds which the testing machine was capable of exerting, although sharp metallic reports were heard when the load reached 6,400,000 pounds and subsequently. The load of 10,000,000 pounds implies a vertical unit compression of about 59,500 pounds per square inch in the cast iron and on the surfaces of contact between blocks. The 300,000 pounds maximum working load above referred to implies a corresponding figure of 1,780 pounds per square inch, but of course the working load is not applied uniformly over the entire length of the block. The following is taken from the report made by Assistant Engineer T. M. Post, of the Washington office, who conducted the tests of this block, from which it will be seen that the capacity of the block is well above 300,000 pounds when loaded in a manner similar to what may be expected in service, no evidence of distress or incipient movement between blocks being noticeable under loads of from

440,000 pounds to 500,000 pounds on a 12-inch length, not only on the center of the block but also 8 inches eccentric either side of the center:

The timber blocks and cap pieces were of first-class quality of white oak, none having any defect which would render the piece unsuitable for the purpose of arriving at the supporting value of first-class bearing blocks in practice. The blocks and cap pieces were ordered 10 by 14 inches and 4 by 14 inches, respectively. The actual cross sections were in most cases  $9\frac{1}{2}$  inches by  $13\frac{1}{2}$  inches and  $3\frac{1}{4}$  inches by  $13\frac{1}{2}$  inches.

The pressure plates through which the load was applied to cap block when timbers were used were of cast iron 14 inches wide,  $1\frac{1}{2}$  inches thick, 12, 24, and 36 inches long, and each planed on both faces.

For each test the keel block was so placed that the center of the loaded area was coincident with the center of the testing machine. As the loads were applied observations were made on each side of the specimen to determine the amount of compression, readings being taken by steel scales of the distance from the underside of bearing plate to the joint between cap piece and top block and also to the top edge of upper casting, measured under the center of pressure.

The following table shows the load for each test corresponding to the approximate elastic limit of the timber, as denoted by sharp increase in the rate of compression, also the maximum load carried. These maximum loads might have gone higher, but the recorded load in each instance corresponds to a condition where the structure of the timber was completely broken down, and further continuance of the tests would have been at the expense of time without deriving information of value.

Test No.	Length loaded.	Center of load.	Load at approximate elastic limit.		Maximum load.	
			Total.	Square inches.	Total.	Square inches.
	<i>Inches.</i>		<i>Pounds.</i>		<i>Pounds.</i>	
1	12	At center of specimen.....	140,000	845	450,000	2,720
2	12	8 inches to right of center.....	140,000	876	440,000	2,660
2-A	12	8 inches to left of center.....	145,000	876	500,000	13,020
3	21	At center of specimen.....	250,000	755	580,000	1,750
4	36	.....do.....	325,000	657	725,000	1,450
5	48	.....do.....	400,000	605	840,000	1,270

<sup>1</sup> After passing elastic limit taper sides of cast-iron filler came into bearing against cap piece, increasing the loaded area.

Before making each test chalk spots were made on each side of keel block at the several joints in the cast-iron section and needle line scribed across the joints to detect any movement of one casting on another under the loading. In none of the tests was any movement of this sort shown.

In making metal-to-metal tests to determine the strength of the cast-iron keel block a cast-iron plate 62 by 20 inches,  $1\frac{1}{2}$  inches thick, planed to parallelism between faces, was inserted between the upper casting and the top head of testing machine to protect the latter from indentation. In the first test (No. 6 of schedule) load was applied over the whole top surface of the assembled keel block. No developments were noted as the load came on until a load of 6,400,000 pounds was reached, when there was a sharp metallic report, as if castings had been struck by a hammer. At intervals there followed other reports, none of them, however, accompanied by any noticeable falling off of the load, and the full capacity of the machine, 10,000,000 pounds, was reached without showing any indication of failure in the exterior faces of the castings. I took measurements of the moving together of the heads of the testing machine, which is a fair measure of the compression in the assembled keel block, taking initial determination at 40,000 pounds. The compression corresponding to each 2,000,000 pounds increase of load is shown by the figures below:

Load.	Reading.
<i>Pounds.</i>	<i>Inches.</i>
40,000	0.000
2,000,000	0.061
4,000,000	0.103
6,000,000	0.152
8,000,000	0.225
10,000,000	0.362

The load was then backed off and the castings taken down and examined. A number of cracks had developed in all of the pieces—in the bottom web of top casting, in the horizontal web of wedge pieces, and in the crosssties of bottom casting.

No actual break had occurred in any of the sections, and the keel block was again set up and centered in the machine and prepared for test No. 7, applying the load over a length of 36 inches through pressure plate 36 by 14 by  $1\frac{1}{2}$  inches, centered over the center of the keel block. This test proceeded without any development, until a load of 6,600,000 pounds was reached, when the first metallic report was given out by the castings. This was followed by other reports as the load was increased. At 9,330,000 pounds cracks were observed, developing in a vertical direction across the outside face of the top casting, also across the lower of the two wedge pieces near the middle. At 9,350,000 pounds the keel blocks collapsed with a crash, breaking into many pieces. The bottom casting was the only one remaining complete, but it was badly cracked. The wreckage of the balance included only three pieces of considerable size, the large end portions of each of the wedge sections, and a large piece from the shallow end of the lower wedge casting, which still rested upon the bottom casting, although jarred out of position.

No movement occurred between the several castings during test No. 6, and no slipping of castings, one on another, occurred during test No. 7 previous to final failure. It should be here recorded that the finished inclined surfaces in bearing had been kerosene-cleaned before tests were commenced, but same were free of oil.

The docking keel blocks are detailed on plate No. 85. Each consists of two sticks of greenheart 14 inches by 14 inches by 8 feet 6 inches, one stick of oak 10 inches by 14 inches by 7 feet 6 inches, one stick of oak 12 inches by 14 inches by 6 feet, and an oak cushion piece 4 inches by 14 inches by 6 feet. The lower portions of the block are firmly bolted together so as to form a permanent block, while the two upper pieces of white oak are secured by dogs and are accordingly easily removable. The docking keel blocks are to rest directly on the concrete dock floor, and each is held in the desired place by four rods each provided with a hook at each end, and with a turnbuckle for adjustment. The upper hook engages an opening in a strap secured to the block, while the lower hook engages a continuous slot sunk in the dock floor. These cast-iron slots are made in sections about 7 feet long, and are provided with holding-down bolts screwed into their bottoms and set in holes formed in the masonry of the dock floor. The object of this detail is to avoid the obstruction of the dock floor by continuous timber bearers permanently secured in place.

The sliding bilge blocks are also built up of greenheart and white oak, and move on cast-iron slides permanently secured to the dock floor, motion being imparted to the block by chains of three-eighths of an inch stock rove through sheaves and operated from the coping in the usual manner. The sliding bilge blocks and appurtenances are detailed on plate No. 85, and the cast-iron slide and its appurtenances are detailed on plate No. 84. Each assembled slide consists of five iron castings laid end to end, which project  $3\frac{1}{2}$  inches above the dock floor and are provided with a toothed rack cast in place and with overhanging edges to engage the holding-down hooks of the bilge blocks. Each assembled bilge-block slide requires an estimated weight of 3,334 pounds of cast iron, 115 pounds of cast steel, and 2.86 pounds of bronze. Contract for these parts was let to the Kilby Locomotive & Machine Works, of Anniston, Ala., at a unit cost for the 102 slides originally ordered of \$65 for the cast iron and \$18.37 for the cast steel and bronze, a total of \$83.37. The order was subsequently increased to 140, and it was necessary to increase the unit price to \$113.05 for such of the additional parts as could not be purchased under the increase clause of the original contract.

*Capstans.*—The dry dock proper is provided with 9 capstans, one at each side of the entrance, one at the head, and three along each side wall, these latter being spaced 277.5 feet centers. In addition there are two similar capstans set outside the entrance to the dock at a distance of about 350 feet from the entrance, on either side of the entrance basin leading to the dry dock, to assist in centering vessels about to enter the dock.

These 11 capstans are identical in power and construction. Each is required to be capable of exerting a rope pull of 35,000 pounds at a speed of 30 feet per minute, or of 8,000 pounds at a speed of 120 feet per minute, and the speed regulation is required to be such that for either of the rope pulls above mentioned speeds approximating 25 per cent, 50 per cent, and 75 per cent of the respective speeds can be obtained. The capstan barrel is driven by an electric motor through a worm and wheel. The worm is coupled direct to the motor shaft, no intermediate gearing being provided. A solenoid brake is provided to prevent the motor being overhauled by any rope pull. Each capstan sets in a concrete pit 8 feet 6 inches by 14 feet, approximately 4 feet 8 inches deep. Each of these pits is provided with a self-draining cover which leads rain water to outlets in such manner that no water falls on the machinery in the pit. The controller shaft is brought up through the pit cover and an extension handle is provided, so that the capstan can be controlled by a man in a standing position, who need not be less than 9 feet from the capstan barrel.

Proposals for these 11 capstans were invited under Circular No. 975 and the following bids were received:

From the American Engineering Co., Philadelphia, Pa., 9 proposals ranging from \$50,930 to \$56,650, depending on the insulation of the motor and the presence or absence of intermediate gearing. Solenoid brakes were offered at from \$1,980 to \$2,475 additional. The time of delivery offered ranged from 220 to 235 days.

From the Hyde Windlass Co., Bath, Me., 1 proposal, \$57,695; time of delivery, 310 days. This proposal included gearing between motor and capstan base.

Contract was awarded to the American Engineering Co. on the basis of its proposal No. 2, including solenoid brakes, the contract price being \$58,960, and time of delivery 235 days.

*Bollards.*—The type of bollard adopted is shown on plate No. 87, and is of cast iron filled with concrete. The top of the bollard is 3 feet 6 inches above the concrete, and the barrel is 1 foot 6 inches in diameter at the top, tapering to 1 foot 4 inches diameter just above the concrete base, an apron or collar being cast integral with the bollard to form a finish and to prevent wear of rope between bollard and concrete base. Each bollard is provided with a "hump" 1 foot 10 inches from its top; the bollard is set so that this "hump" is on the side away from the dock coping. Bollards of similar dimensions are used on the entrance pier, but the "hump" is replaced by a 3-inch diameter "norman" which extends completely through the shaft of the bollard and projects 4 inches on either side. Modifications are made in the detail of the bases of the bollards to suit the conditions of their emplacement; the greater part of those around the dry dock are provided with a 4-foot extension below the surface of the concrete base, this extension being 1 foot 4 inches in diameter and set in a socket formed in the concrete base. For the entrance pier, this



deep base is replaced by a shallow spread base which is provided with holes for four 1 $\frac{1}{4}$ -inch diameter anchor bolts set on the corners of a 25-inch square.

*50-ton locomotive crane.*—Mention was made in the last annual report of provision for a 50-ton locomotive crane to serve not only Dry Dock No. 1, but also adjacent wharves. Proposals were invited under Circular 973 for furnishing fabricated material for this crane, the erection of which is to be done by The Panama Canal. But one proposal was received, this being from the American Hoist & Derrick Co., of St. Paul, Minn., the contract price being \$57,679.50. This crane will be provided with three hoists known as main hoist, auxiliary hoist, and whip hoist, of 50 gross tons, 15 gross tons, and 3 gross tons rated capacity, respectively. It runs on a track consisting of two 135-pound rails laid 22 feet center to center on tangents, and is supported on eight 2-wheel trucks, making a total of 16 wheels. The traveling structure is articulated to enable the crane to pass the various curves, the minimum radius of which is 86 feet 2 inches to center line of track; this curve follows the semicircular head of the dry dock.

The main hoist has a maximum reach of 87 feet from the center of the track and a hoisting speed of not less than 10 feet per minute. The auxiliary hoist has a radius of 97 feet from the center of the track, and the speed of hoist is not less than 20 feet per minute. The whip hoist has a radius somewhat greater than the auxiliary hoist, and a hoisting speed of not less than 40 feet per minute. The power is steam, with oil burning boiler, and the crane is self-contained and self-propelling, of steel construction throughout. Delivery will not commence before the early part of the calendar year 1917.

*Status of office work.*—At the date of this report all construction drawings have been completed for Dry Dock No. 1. There are still under way the detail construction drawings for the concrete deck and beam encasement of a section of quay wall known as "C-D-E," which is located to the north of Dry Dock No. 2 and covers an irregular area about 120 feet square. This section of quay wall supports a portion of the track for the 50-ton locomotive crane and two standard-gauge tracks, and when it has been built it will complete the quay wall construction now authorized in this vicinity. The structural steelwork is not expected to arrive on the Isthmus until after the close of this fiscal year.

The pumping machinery is expected to be in condition to enable the contract acceptance tests to be commenced shortly after the beginning of the fiscal year 1917, at which time the operation of the flooding and sluice valves will also be tested.

#### ENTRANCE PIER NO. 9.

Last annual report gave the general dimensions of future Dry Dock No. 2. As stated in that report, the south wall of this dock forms a part of the entrance pier to Dry Dock No. 1; the dimensions of this pier were given in the 1915 report as 59 feet wide by 350 feet long. During the fiscal year 1916 the entrance pier has been completed, including an extension at its westerly end, with the result that the completed pier is 480 feet long, of which the "original" portion is 59 feet wide by 348.5 feet long and the extension is 37 feet wide by 131.5

feet long. The extension will serve as an entrance pier for future Dry Dock No. 2, and it has been built in such manner that it will act as a cofferdam in excluding water from the excavation for Dry Dock No. 2, when the construction of that dock is resumed.

All construction drawings have been completed for the entrance pier, and no material remains to be purchased on requisition.

#### RADIO STATIONS.

The 1915 report stated that the radio stations at Darien, Colon, and Balboa were practically completed during that fiscal year. The few outstanding matters, such as cleaning up and the completion of the subsequently authorized operating platforms on the towers, were finished early in the fiscal year 1916, and the inspection force was disbanded on August 30, 1915.

#### FLOATING CRANES.

Assistant Engineer Henry Schoellhorn continued in charge of the inspection of the *Ajax* until his work was completed. He left the Isthmus on November 30, 1915.

The *Hercules* has been tested and accepted by The Panama Canal on March 30, 1915, and assigned to the mechanical division for operation. At the beginning of the present fiscal year the repairs to the damaged superstructure of the *Ajax* had been completed and all the material for the new jib which had been manufactured at the contractor's home works in Germany had been received on the Isthmus during June, 1915. The jib of the *Hercules* and the original jib of the *Ajax* were placed at Gatun Locks. As the assignment of a lock chamber for this purpose was not possible, to place the new jib of the *Ajax* the contractor decided to assemble the new jib on the ground at Dock No. 14 in two sections and to hoist the sections separately into place by the *Hercules*. The larger section includes the heel, or pivot, end and weighs about 109 long tons and was assembled and riveted on the deck of the *Ajax*. The smaller section, forming the head of the jib, weighed about 50 long tons and was erected on the ground back of Dock No. 14.

The work of raising the jib by the *Hercules* began on August 4, 1915, and the first or larger section was handled into place without any mishap. On August 7 the smaller section was placed and connected to the first section. The contractor completed his work and offered the *Ajax* for acceptance test on September 1, 1915. The crane was subjected to the same contract tests that were required of the *Hercules*, including the 20 per cent excess test loads for the main hoists, deck load test, the auxiliary hoist tests, stability tests, the safeguards against complete breakdown were tested, and the speed of the different operations and the power required were recorded. Measurements were made of the inclinations and freeboards for each load at the rated reach with the jib overend and the jib over-side. The tests were satisfactory and all requirements of the contract were met. The tests were completed on September 18, 1915, and the crane was taken over for operation by the dredging division on September 21 and was formally accepted on September 30, 1915.

## BALBOA WHARVES AND PIER.

Assistant Engineer W. Rowland continued in immediate charge of design and office engineering during the year, connected with Pacific terminal docks Nos. 1, 6, 7, 13, 14, 15, 16, 17, 19, and Pier No. 18, until this work was completed on May 10, 1916.

The work of this section included the following:

*Pier No. 18.*—Drawings were completed and requisition prepared for the 900-ton steel collars or ties for bents 20, 25, 30, and 35. The plans which were followed for decking the center part of the pier, consisting of brick laid on a coral fill inclosed by a concrete wall supported by wooden piles, were completed. Plans and requisitions were prepared for two 10-ton railroad depot scales and also for the twenty-two 3-ton cargo-handling booms, which are supported by the vertical columns with brackets 27.5 feet above the floor of the pier. The pier-shed offices included baggage room, baggage office, mail room, and toilets, and the plans for the same were prepared along the lines desired by the Panama Railroad. Drawings in connection with the various details were completed.

*Docks Nos. 14, 15, and 16.*—The layout of air and water pipes, electric light, power and telephone conduits were revised to meet the operating requirements, and work requests were issued on the different divisions concerned for the installation thereof. To prevent damage to the vertical fenders a system of horizontal floating fenders was designed. Since these horizontal fenders have been installed no repairs to the fender system have been necessary.

*Unloader wharf No. 7.*—Local conditions prevent the building of the standard buttress for bents 39 and 40. In bent 39 only the rear part of the buttress was built to rock and a 6-foot cylinder was sunk near the front face of the wharf. A deep reinforced concrete girder, resting thereon was designed to support the decking. In bent No. 40 four 6-foot cylinders were sunk, and a continuous reinforced concrete girder 13 feet deep was designed, connecting the cylinders and carrying the beams of the decking and the apron wall.

The water piping was revised to provide connections from which to feed the boilers of the unloader towers. Two-inch outlets with connections for feed-water hose of the unloader towers were spaced every 100 feet. The cast-iron outlet boxes for the new outlets were ordered from the mechanical division.

*Reloader wharf No. 6.*—Drawings for the structural steel decking were finished and checked. Drawings for the bracing between the cylinders and for the cylinder reinforcement were completed. To avoid excessive earth pressure the back fill was sloped up behind the dock to  $1\frac{1}{4}$  to 1, leaving an opening about 25 feet between the top of the slope and the rear of the wharf. A driveway was provided to the wharf at the trestle loop. Plans for the anchorage system were completed, including a continuous concrete wall, except for nine bents at the south end of the wharf, where, on account of interference caused by adjacent structures, individual anchors were adopted. Drawings were prepared for the piping for fuel oil and compressed air, with valves and service connections underneath the front face of the dock. The outlets, with hose connections, are located in manholes cored out in the deck slab, and closed with cast-iron covers. A 6-inch water main is supported by reinforced concrete brackets at the rear

face of the dock, with 4-inch branch lines provided with meters and gate valves, carried on the floor of the dock below the viaduct, and protected by a reinforced concrete box with iron cover.

*Docks Nos. 17 and 19.*—During the year the drawings were completed for the four reinforced concrete pontoons forming the small-boat landings at Docks Nos. 17 and 19. A design was developed of collapsible forms for the concrete above the construction joint in such a way that all parts could be passed through the 18-inch man-holes. The setting of reinforcing bars, as well as the building and assembling of forms was checked twice a week while work was in progress. These pontoons are similar, with over-all dimensions 28 feet 2 inches beam, 120 feet 6 inches long, and 8 feet deep. They are designed for a freeboard of 3 feet, with bottom and side slab 5 inches thick, ends 10 inches thick, and deck slab 4 inches thick. On the latter was provided a 2-inch wearing surface of asphaltic concrete. The pontoons have a system of two longitudinal 4-inch bulkheads and five transverse 4-inch bulkheads dividing each pontoon into 18 water-tight compartments. In addition there are 12 transverse frames.

#### CONSTRUCTION WORK, FIELD ENGINEERING AND INSPECTION.

##### PACIFIC TERMINALS.

General Superintendent J. A. Walker continued in immediate charge of all construction work, including shops, dry dock, wharves and piers, coaling plant, Sosa Hill excavation and other construction work performed by this subdivision until August 2, 1915, when he resigned to enter into contracting. He was assisted by Assistant Engineer H. D. Hinman, who was also in immediate charge of field engineering and inspection of all construction and contract work. From August 3, 1915, to April 30, 1916, Assistant Engineer H. D. Hinman was in charge of all construction work, field engineering, and the inspection of all contract and construction work. From August 3, 1915, until he resigned, effective April 2, 1916, Mr. E. W. Baldwin held the position of supervisor in the Pacific terminals organization.

##### GENERAL.

There were excavated during the year 587,336 cubic yards of material; 511,092 cubic yards were excavated from Sosa Hill and 424,231 cubic yards of this were delivered to the east breakwater at the Atlantic end of the canal. The remaining amount of material was used for miscellaneous purposes, such as back fill around dry dock, docks, wharves, and yards at Balboa, and furnished to other divisions. In connection with excavation, the removal of the cofferdam, and with the dry dock and Sosa Hill quarry, there were drilled 245,813 linear feet of holes and 223,369 pounds of explosives were used. There were 48,781 linear feet of railroad track laid, and 59,949 linear feet were removed. A total of 71,648 cubic yards of concrete was placed—26,780 cubic yards being classified as "mass" and 44,868 cubic yards as "reinforced." There were used in connection with placing concrete 4,290,571 pounds of reinforcing steel; and there were embedded in this concrete 2,121,013 pounds of fixed

steel. There were 137,190 linear feet of piles driven on miscellaneous work around the terminals. Most of the caisson work was performed for the reloader wharf and for Dock No. 13 (quay wall C-D-E), necessitating 3,658 linear feet of caisson penetration. There were approximately 7,006.98 tons of structural steel erected during the year in completing the dry-dock gates and in connection with the wharves and docks.

#### DRY DOCK NO. 1.

*Concrete.*—Early in the year, the excavation and cleaning of the rock in preparing foundations was completed. Most of the mass concrete had been placed at the end of the last fiscal year—that remaining to be done comprising the entrance on each side, the pumpwell and the opening which was left to accommodate the mixing plant. The reinforced concrete to be placed was for several machine rooms, the copings, drains, and gutters and numerous small lots around the metal parts and the coping level. The mixing plant was described in last year's report. It remained in service until the latter part of August, when it was removed and the mixers mounted on cars fitted with a tower and chutes for delivering the concrete into forms—this plant being well adapted where small quantities were required at different points, on account of the ease with which it could be moved. The progress of the work was materially hindered on account of delays in shipments of fixed irons due, in part, to the congested condition of railroads in the States and scarcity of bottoms. The trestle leading into the dry dock was dismantled in December, 1915, and the floor was finished in January, 1916. There were placed during the year 12,897 cubic yards of mass concrete and 17,617 cubic yards of reinforced concrete, in which 1,043,366 pounds of reinforcing steel and 1,122,236 pounds of fixed steel were embedded. The average unit cost to April 30 of mass concrete in the dry dock was \$4.12 per cubic yard, and of reinforced concrete, \$6.74 per cubic yard.

*Granite.*—The granite blocks forming the miter sill, or bottom bearing for the gate, were placed during the fiscal year. One-sixteenth of an inch was allowed in setting them for dressing down. The blocks forming the quoin posts, or vertical bearings, were placed early in the fiscal year, three-eighths inch being allowed for finishing, and work was at once begun to bring the surfaces to a true plane. The granite seat for the floating caisson was also put in place and finished off. Special steel templates were prepared to gauge the surfaces; and the work was done with such nicety that when finished the maximum variation of the granite caisson sill from a true plane was one thirty-second of an inch. The maximum variation of the vertical quoin posts from a true surface was one sixty-fourth of an inch, while that portion of the posts where steel bears against granite at the bottom checked less than one four-thousandths of an inch from true. The joints between all blocks were faced off with sheet lead.

*Miter gate.*—The south leaf of the dock gate was erected, riveted, and placed on its pintle by November 27, 1915, and the north leaf by December 14, 1915. The cost of erecting the gate leaves, exclusive of greenheart, gate carriages, painting, and inspection was \$80.26 per ton, to April 30, 1916. The greenheart for the miter gate and for

other purposes connected with the dry dock came from British Guiana. That for the quoin ends and miter ends was placed after the gates had been put into position, working from the floor of the dry dock. The final finishing was not completed until the end of March. The gate leaves were swung to open position in order to facilitate the adjusting of the greenheart. In order to relieve the pintles of a part of the load, carriages with wheels running on rails fixed to the floor were temporarily connected to the underside of each leaf near its free end. After the leaves were tested for water-tightness, they received inside and out a coat of bitumastic solution and one of enamel.

*Pumping plant.*—The machinery for the pumping plant for unwatering the dock, contracted for by Henry R. Worthington (which was described in the annual report of 1915), began to arrive in January, 1916. Erection was started in February, since which time it has gone forward as rapidly as possible. The contractor's representative, Mr. Ira W. Dye, has, in accordance with the terms of the contract, acted as superintendent of erection for The Panama Canal. All of the various pumping units, with motors and valves, have been installed, as has also the greater portion of the brass pressure piping for hydraulically operating the valves. The pressure pumps and accumulator have been set up, but have not yet been connected. There remain to be placed the control or operating table, after which all iron surfaces are to be coated with bitumastic enamel. All conduits for electric wiring have been put in and electric indicator boxes attached to the valves. The electrical control panels have been partly erected and will be completed and all connections made by the time the pumps are made ready for the tests.

*Flooding and sluice valves.*—The valves, including operating machinery and housings or guides, were furnished by R. D. Wood & Co. A description was given in the annual report of 1915. The sluice-valve housings were embedded in the monolithic concrete. Recesses were left in the concrete for the housings of the flooding valves and subsidiary guard valves, thus allowing a more accurate aligning and rigid bracing when they were concreted in. The valves arrived in February, 1916. Forces of the mechanical division fabricated the greenheart and fir guard valves, which were installed by this division in April. At the end of May the flooding valves with pressure piping were practically completed, and the sluice valves were 85 per cent completed. Installation of the control table had not been started.

*Keel and bilge blocks.*—The transverse slots across the floor at 4-foot intervals throughout the entire length of the dock were made by tripod drills, together with holes for anchor bolts. Where the floor was accessible this work was finished on March 30, 1916. Owing to the delay in the delivery of the keel and bilge-block material, including the holding-down slots and bolts, the placing of the blocking system had not been started on May 31. To provide a true plane working surface for the floor of the dock in placing the trough sections for holding-down bolts, it is proposed to finish the floor off throughout its full length and for a width of 66 feet with a cement mortar finish to elevation minus 39.4.

## ENTRANCE BASIN.

*Excavation.*—No excavation was necessary in the entrance basin during this year, except some handwork in connection with placing a concrete apron in front of the entrance of Dry Dock No. 1, and leveling the bottom of this basin so that it would all be below elevation minus 45. All tracks and other material were removed prior to April 1, 1916.

*Cofferdam.*—The cofferdam, which has held the water out of the area occupied by the dry dock, unloader wharf, entrance pier, and basin, was drilled for blasting during February, March, and April. The cofferdam was blasted on the outer side in small shots, as much as possible before making the final shot completely through it. The drilling was done in three shifts, using well drills, and there were drilled 69,680 linear feet of holes at a labor cost of approximately 17½ cents per linear foot. In order that the drilling might extend outward toward the canal, as far as where the rock surface lay at about elevation minus 45, a wooden trestle was driven, and the well drills were worked from it. Sufficient drilling was done by April 1 to permit an opening to be blasted through the cofferdam approximately 180 feet wide. No dredges being available, it was not until April 23 that the main blast, consisting of about 14,000 pounds of 60 per cent dynamite, was made. The shot was made as small as possible so that there would be less likelihood of doing injury to the near-by structures. Before shooting, water was pumped into the entrance basin and dry dock by dredge No. 85, to elevation minus 15. The concrete barges, which had been constructed on the floor of the dry dock, were floated out and moored to the dock walls in the entrance basin. As soon as the shot was made and the concrete barges had been floated out of the dry dock, the entrance gates were closed, and after some portable pumps had been installed, the dock was pumped out and it has been kept dry since. The entrance gates proved to be thoroughly tight under pressure.

## ENTRANCE PIER NO. 9.

The gravity wall, which was designed to form the south wall of proposed Dry Dock No. 2, was completed last fiscal year. Of the length authorized, there yet remained the head wall and the concrete steel decking. These were completed in March, 1916. In January an extension of 131 feet to the gravity wall at its outer end was approved. This extension consists of a steel and concrete deck supported on monolithic concrete piers. The site was excavated by steam shovel, and rail anchorages were put into the rock. A curtain wall was also provided to act as a cofferdam when Dry Dock No. 2 shall be built. This extension was completed before April 1, including fender piles. There were placed during the year in the entrance pier and head wall, 5,338 cubic yards of mass and 3,966 cubic yards of reinforced concrete. The average cost per cubic yard of mass concrete to April 30, in the entrance pier, was \$4.76, and of the reinforced concrete \$8.74.

## COALING PLANT.

*General.*—The coaling plant has been described in previous reports. The work performed this fiscal year consisted of a continuation of the construction of the coal pockets and wharves by The Panama Canal, and of the erection of the coal-handling machinery by the contractors.

*Coal pockets.*—There were excavated 1,760 cubic yards of rock. The Panama Railroad tracks were removed from the site of the east coal pocket, and the excavation in this pocket completed, the floor being leveled and rip-rap retaining walls built. All the rip-rap walls around the coal pockets were completed at the end of April, with the exception of the north half of the west coal pocket in the vicinity of the anchor wall behind the reloader wharf. Prior to flooding, cross-sections from which the capacity of the pocket could later be computed, were taken over the subaqueous area.

*Unloader wharf, Dock No. 7.*—At the close of the last fiscal year this wharf had been completed up to the point where it intersects the cofferdam, or about four-fifths of its length. The foundations are anchored piers resting on solid rock, extending in front down to elevation minus 46. Where Dock No. 7 intersected the cofferdam this design was modified. Interlocking steel sheet piling was driven around the area to be occupied by each of these piers, allowing enough clearance for forms, and the material therein excavated by orange-peel bucket down to rock, which was found between elevation minus 25 and minus 30. Heavy timbers were used to brace the steel walls against the earth pressure. The rear portion of the piers was then built, bonding rails and grooves being supplied on the front face. At the same time open excavation was carried down at the face. The seamy rock allowed so much water to enter the holes that steel caissons had to be used for some piers before the final penetration could be attained. The caissons were cut off as low as possible in every case, and the piers carried up solid from that point. On the most westerly bent caissons were used entirely, capped by a heavily reinforced concrete beam. All foundations were completed in March, and the floor system in April. Concrete for the floor was mixed by a portable plant mounted on the wharf track. Fender piles were put in position as far as the conditions would allow. In the vicinity of the cofferdam piling can not be placed until the excavation of the cofferdam is completed. There were placed during the year 4,835 cubic yards of mass and 2,460 cubic yards of reinforced concrete, in which there were used 236,133 pounds of reinforced steel and 70,838 pounds of anchoring rails. The total yardage of mass concrete in this structure was 19,508 cubic yards, and the unit cost per cubic yard was \$4.90 to April 30, 1916. There have been placed 6,118 cubic yards of reinforced concrete, which has cost \$8.22 per cubic yard.

*Reloader wharf, Dock No. 6.*—At the close of the last fiscal year most of the cylindrical piers had been finished, those remaining being a few near the junction of the unloader and reloader wharves, and the 8-foot diameter piers under the wharf bunker. Two difficulties presented themselves in working the 8-foot cylinders: (1) When the toe reached stiff clay the frictional resistance became so great that the shell could not be driven any farther, and (2) at about 50 feet below ground level the pressure on the shell was great enough in



several cases to crush the caisson. The same remedy was applied in each case: (a) A short caisson,  $7\frac{1}{2}$  feet in diameter, with heavily reinforced toe, was inserted; (b) an angle bar with iron brackets to strengthen it, was riveted around the inside at the top and bolted sections of 6-foot caissons set on it to act as a "follower" on which to rest the driving hammer; and (c) the crushed section of 8-foot shell was cut and removed, after which the inner cylinder was sunk without much difficulty. Six panels of the floor were completed by January 15 to allow the contractor under Washington Order No. 40483 to start erecting the reloader towers. The work on the floor progressed thereafter at the rate of two to three panels a week until it was finished. Three sets of steel rods at every bent tie the wharf to a continuous anchorage buried in the fill 90 feet behind the wharf. For the north half of the dock this anchorage consists of a concrete wall 6 feet wide by 9 feet high supported on two rows of wood piling, the outer of which is inclined toward the wharf at the bottom. Heavy concrete "deadmen" were placed at the south end of the wharf. To minimize the thrust on the wharf, the back fill is sloped  $1\frac{1}{4}$  feet horizontally to 1 foot vertically from a line 25 feet back of the wharf, the slope being riprapped down to low water. There were 1,693 linear feet of 6-foot and 184 linear feet of 8-foot caissons and 61 linear feet of 4-foot caissons driven during the year. The average cost per cubic yard for all excavation in caissons for this dock, exclusive of the cost of pumping and maintenance of equipment, was \$2.011. There are 6,170 cubic yards of concrete filler in the substructure (including 200 cubic yards placed last year), and 4,756 cubic yards in the superstructure, all of which is reinforced. The average unit cost of concrete filler was \$3.97, and the reinforcing in it \$2.50 per cubic yard. The concrete decking, including reinforcing and forms, cost \$9.06 per cubic yard.

#### COAL-HANDLING MACHINERY.

*Unloader towers.*—Washington Order No. 40587 (Hunt Construction Co.). At the end of the last fiscal year one tower had been erected to the 60-foot level, but had not been riveted. The erection and riveting of the two towers were completed by the 1st of September, and by the end of September the towers had been given the first field coat of paint. Both towers were given their second coat of field paint during January, 1916. The general work of machinery installation by the Hunt Construction Co. was started on September 2, 1915. On April 30, 1916, the unloader towers were completed in all their essential parts with the exception of (1) modifying 50-ton hoppers; (2) providing water side trucks with aprons and rail scrapers; (3) providing protection against falling coal for the stair landings on the water side; (4) providing cast-iron babbitted outboard bearings for crank shaft of 12 by 14 inch engines; and (5) completing the lighting system. During April the engines in both towers were run light, but there was no handling of coal.

*Reloader towers.*—Washington Order No. 40483 (Augustus Smith). The erection of the two reloader towers, Nos. 5 and 6, was begun on February 16 and 18, 1916, respectively, and at the end of February erection of the steel framework of both towers was practically complete. The riveting of the two towers was completed in March, and

Tower No. 5 had been given a first coat of field paint. By April 30 both towers had been given their first and second coats of field paint. The galvanized corrugated coverings of the operator's cabs and machinery houses were completed and the window frames installed. The erection of machinery had not been started.

*Conveyer system.*—The erection of viaduct steel started in October, 1915, when 99 tons were placed on the straight runs along the north and south sides of the coal pockets. The foundations for the viaduct were completed a few at a time, and steel was erected intermittently on all available foundations. On April 30, 1916, 257 tons, or approximately 85 per cent, of the viaduct steel had been erected. The painting of the steel immediately followed the erection. The erection of the transformer house steel was begun on March 13, 1916, and on April 30 the north bay was still unerected an account of the foundations being inaccessible. Riveting was begun on April 20, and on April 30 approximately one-quarter of the total number of rivets had been driven. Structural steel for the conveyer and office tower had not arrived on April 30, 1916. The erection of the structural steel for the wharf bunker was begun on March 24, 1916, and completed on April 13, 1916. Riveting was commenced on April 1, 1916, and on April 30, 15,306 rivets (approximately 75 per cent of the total) had been driven.

The erection of the rehandling or "berm" cranes was completed in the last fiscal year. All mechanical installation was completed the first week in September, and the cranes given their first coat of field paint. The cables will not be swung until the cranes are desired for operation. On April 30 the power installation within the cranes themselves had been completed, but nothing had been done toward the lighting system.

#### REPAIR WHARVES AND COMMERCIAL PIER.

##### REPAIR WHARVES.

*Dock No. 13, quay wall C-D-E.*—The two remaining caissons of this dock were finished and the floor slab poured early in the year. Later an extension was authorized necessitating the placing of 21 more 6-foot caissons, and also caisson supports for the crane tracks from the dry dock to Dock No. 13, requiring seven 6-foot caissons and five 4-foot caissons. All except three of these foundations were finished by the end of December, 1915. There were 1,134 linear feet of penetration for 6-foot caissons, and 297 linear feet for 4-foot caissons. The average cost of excavation in caissons, exclusive of pumping and maintenance, was \$2.65 per cubic yard, and the average cost of concrete filler, exclusive of reinforcement (which cost \$1.67 per cubic yard) was \$3.86 per cubic yard. The most difficult work in connection with this dock was that of placing the anchorages. Coral rock was obtained from Cristobal to use as a fill on account of its light weight. Immediately behind the dock rock from Sosa Hill was unloaded to form a toe to hold the coral and earth fill. No pile fenders have been installed because the material has not been excavated in front of the dock.

*Dock No. 14, quay wall E-F.*—Fill was placed behind the dock, Sosa Hill rock being plowed off Lidgerwood cars from a track near its rear face, making a rock toe along the rear edge of the dock to hold the

earth and the coral fill placed farther behind. The anchorages were all put in place, the ground leveled, the piping installed, and the permanent tracks brought to their final level. Vertical and horizontal pile fenders were installed along this dock.

#### COMMERCIAL PIER.

*Pier No. 18.*—The weight of back fill in the unpaved center portion of the pier on the soft underlying mud caused it to spread slightly at different points, and during the past year the top of the fill was excavated, and work started on placing two additional tie-rods 3½ inches in diameter at each bent. Four sets of bands of heavy steel plate were ordered to encircle the caissons forming bents Nos. 20, 25, 30, and 35. The rods were all in place by October, the bands were received in February, and erection finished in April. A double row of piles was also driven around the entire inner face of the deck slab on which was placed a concrete wall, which acted as a retaining wall to hold the coral rock. The center section was then rolled and paved with wood blocks and brick. There has been no further movement. Erection of the steel shed was started in July, and when it had progressed far enough to permit it, the pouring of the concrete walls was started. The shed contains 1,930.5 tons of steel erected at a cost of \$15.52 per ton, and 1,390 cubic yards of concrete costing \$24.83 per cubic yard, including forms and reinforcement. The roof is of "Bonanza" tile similar to that for the shops' buildings. The sliding sectional doors, furnished by the J. Edward Ogden Co., began to arrive in February, and erection was started in March. On May 31 erection was 60 per cent complete. There yet remains to be placed the cargo booms and the concrete telephone booths.

#### REINFORCED CONCRETE PONTOONS.

It was decided to construct the four reinforced concrete pontoons or barges to be used as small-boat landings in slips Nos. 17 and 19, Balboa, on the floor at the head of the dry dock, this being the most convenient location. About 178 cubic yards of concrete and 34 tons of reinforcing bars were required for each pontoon. The entire bottom, sides, interior bulkheads and frames, up to a height of 6 feet, or 2 feet from the top, were cast in one continuous pour. The pontoons cost complete, with all accessories, about \$44,000. After being flooded the compartments were found to be quite tight, and very little subsequent caulking was necessary.

The reinforcement was set with the greatest possible accuracy because of the comparative thinness of the walls. The floor and sides of the first pontoon were concreted on January 28, and the remaining three the following month. A mixture specially rich in cement was used, and the aggregate was sand and screenings to insure an even flow and to prevent honeycombs. The forms for the deck were made in sections small enough to allow them to be removed through the manholes which were placed in each compartment, so that only one set of forms was required for all four pontoons. The first pour for the decks was made in February and the last of March. The forms were stripped and the sides waterproofed by the "Sylvester process." The floor forms were anchored to the dry dock floor so that the pontoons pulled away from the forms when water was turned into the dry dock.

## QUARANTINE BOAT LANDING—DOCK NO. 1.

The pier for the Balboa quarantine station, which was designed by this division, and the contract for the construction of which was let to Mr. A. P. Crary on March 22, 1915, was completed during the fiscal year. The work to be completed consisted of the placing of the larger part of the decking. A supplementary contract was entered into with Mr. Crary to construct a concrete walk leading to this landing, and all of the work was completed. A steel pontoon and a steel landing bridge similar to those for Docks Nos. 17 and 19 were placed by this division at the sea end of the pier, dolphins were driven, and the complete structure turned over to the health department on November 17, 1915.

## BALBOA SHOPS.

A little work remained to be done in connection with Balboa shops. There was a small stretch of tunnel to complete where the incline leading to the dry dock had delayed its construction. The floor of the drainage system was carried out and connected up with that of Dry Dock No. 1. The north crane runways to Building No. 1 were aligned and completed as soon as the fill in the vicinity had been placed. The transfer table was completed; the fill completed and the track connections made to it. All of the permanent tracks in the shops' yards were completed. The piping for electric lines, air, and water were installed. The electric lighting for the shops' yard was put in, and the construction of the asphalt road was completed as far as authorized. The work of installing the lighting system and the construction of the roads was performed on work request by the electrical and municipal engineering divisions, respectively. A considerable amount of repairs to the roofs due to the blasting operations in Sosa Hill quarry was performed. The pump and compressor house, Building No. 29, which has been considered as one of the Balboa shops' buildings, is situated on the south side of Dry Dock No. 1. No work could be performed on the footings of this building until the dry-dock walls had been nearly completed in the vicinity. The footings were placed on rock and the steelwork erected as soon as it arrived on the Isthmus. The delivery of the steel framing was greatly delayed. The erection of the steelwork was started on March 6 and the riveting on March 27, 1916. The erection was completed in March, the steel amounting to 295.48 tons. The placing of the concrete walls and tile roof for this building was turned over to the building division on April 20, 1916. The air-compressor machinery was installed by the mechanical division in December, 1915, and was placed in service early in 1916.

## SOSA HILL EXCAVATION.

At the beginning of the fiscal year very little work was being performed in Sosa Hill quarry, the breakwater not being ready to receive rock in any quantity. It was at first thought desirable to operate Sosa Hill quarry by contract, and bids were opened for the excavation and loading of rock for the east breakwater on August 28, 1915, but no award was made, and it was decided to perform the work by Panama Canal forces. In order to procure as much armor rock as possible, a great deal of preparatory work was necessary, and it

was decided to work the quarry on two levels. While the upper level was being prepared by building an incline at the east end of the hill and overcasting material handled by one shovel cut, work on the lower level could be carried on only at a limited rate to avoid interference with the upper-level operations. Two steam shovels were worked on a 12-hour basis on the upper level. In October 4 steam shovels worked 8 hours a day loading rock, and in addition 2 steam shovels on the upper level worked 12 hours a day overcasting. In October a yard was constructed at Sosa Hill in order to handle trains more rapidly at the hill, and on account of the increased output. In November the upper level was in shape to load, and six 95-ton steam shovels loaded rock 8 hours per day—3 on the lower level and 3 on the upper level. Thirty per cent dynamite was largely used, and the results obtained from this in getting out armor rock were very satisfactory. There were excavated during the fiscal year 511,092 cubic yards, of which 359,472 cubic yards of core and 62,388 cubic yards of armor rock were shipped to the east breakwater. The percentage of armor rock to the total quantity excavated was 12.2. The cost of excavation for the year was \$0.5719 per cubic yard. The following table shows the cost per month, including all overhead, and covers the total cost of the excavated material loaded on cars and delivered to the Balboa yard:

Month.	Cubic yards.	Total shipped to east breakwater.	Per cent armor rock to total rock delivered.	Cost per cubic yard.
1915.				<i>Cents.</i>
July.....	10,914	3,468	60.0	1.6334
August.....	40,824	27,952	8.5	.7935
September.....	41,570	36,537	15.9	.6159
October.....	61,526	61,198	10.9	.6858
November.....	84,231	82,527	8.7	.5351
December.....	89,426	77,625	14.3	.4340
1916.				
January.....	75,420	53,850	20.9	.5907
February.....	74,761	61,128	21.0	.4031
March.....	26,689	15,278	14.2	.4523
April.....	5,731	2,357	38.7	.6277
Total.....	511,092	421,860		
Average.....			14.8	.5719

A steam shovel was also operated in earth a part of the time on the lower level at the east end of the hill. This dirt was obtained for back fill around the terminals.

TABLE No. 1.—Statement of work done, Pacific terminals, July 1, 1915, to June 30, 1916.

## GENERAL SUMMARY OF WORK.

[illegible]

TABLE No. 2.—Statement of work done, Pacific terminals, July 1, 1915, to June 30, 1916.

## EXCAVATION (CUBIC YARDS).

[illegible]







										50	186
Miscellaneous:	46										
Not otherwise classified:											
Other divisions:	544	80									819
Panama Railroad.....								195			
Electrical division (old condenser battery, East Balboa).....											
East breakwater.....	3,408	28,448		1,016				588			4,090
Fortification, Naos causeways.....	1,276		61,198	83,385				79,158	15,278	2,357	424,231
Fortification, Naos Island batteries.....			280								1,556
Fortification, Naos Island, mine dock.....											1,938
Cristobal coal pocket.....	320			120				331	1,493		120
Cristobal, Pier No. 7.....	24										778
Municipal division.....				304					127		328
Dredging division.....		3,118									3,118
Fortification, Fort Anador.....	742										742
Hunt Construction Co.....											30
Fill from excavated material.....	25,112	43,752		93,108	96,579	80,426	90,949	29,563	6,265	166	580,544
Fill from gravel, coral, etc.....	746	1,222		5,134	3,560	5,445	18,350	4,967	880	1,215	46,466
Fill from waste dumps.....									253		253
Total.....	25,858	44,974	64,486	98,242	100,139	85,871	109,209	34,783	7,145	1,381	627,263
Summary:											
Terminal, work fill.....	7,701	10,639	2,202	10,012	19,648	32,021	46,106	19,472	4,788	1,381	167,557
Terminal, plant fill and waste dumps.....	11,843	2,689	806	3,405	241			33			21,844
Total fill.....	19,544	13,328	3,008	13,417	19,889	32,021	46,106	19,505	4,788	1,381	189,401
Other divisions.....	6,314	31,646	61,478	84,825	80,250	53,850	63,193	15,278	2,357		437,862
Grand total.....	25,858	44,974	64,486	98,242	100,139	85,871	109,209	34,783	7,145	1,381	627,263
Summary, east breakwater:											
Core rock.....	1,360	26,064	54,520	76,225	68,034	42,586	48,280	13,102	1,445		361,813
Armor rock.....	2,048	2,384	6,678	7,160	11,104	11,264	12,818	2,176	912		62,388
Total shipped.....	3,408	28,448	61,198	83,385	79,138	53,850	61,128	15,278	2,357		424,231
Rock shipped (not from Sosa Quarry):											
Included in core rock.....											2,371

1 Dry dock—duet line.

TABLE No. 4.—Statement of work done, Pacific terminals, July 1, 1915, to June 30, 1916.  
CONCRETE PLACED (CUBIC YARDS).

	July.	August.	Septem-ber.	October.	Novem-ber.	Decem-ber.	January.	Febru-ary.	March.	April.	May.	June.	Total, fiscal year.
Dry Dock No. 1:													
Mass.	3,674	1,841	1,310	1,280	980	820	1,031	703	987	321			12,897
Reinforced.	2,778	2,419	1,649	2,543	2,149	2,577	1,871	834	638	159		115	17,557
Storm sewer.		78	132	157	192	320	125	498	425	29			1,956
Ejector pit and duct line.								61	14	50		22	154
Dry dock gate (coke concrete in bottom gate and footwalk slabs).								6					9
Entrance pier:													
Mass, walls.			132	81	497	685	100	1,371	165				3,031
Mass, piers.	32						1,055	908	252				2,307
Reinforced, walls.		5	28	451			1,204	1,084	165			18	1,956
Reinforced, piers.	123	7											130
Reinforced, deck slab.				609	105	620			438	126			1,838
Dry Dock No. 2:													
Mass, walls and floor.			132	81	497	685	100	1,371	165			18	3,031
Reinforced.		5	28	451									502
Coaling plant:													
Coal pocket—													
Mass, walls.	13				11	4			38	35		20	121
Reinforced, walls.	277				6	6	5			135			412
Mass, viaduct foundation.										21	128		166
Reinforced, viaduct posts.	271												271
Berm crane foundations—cable anchorage.											9		9
Coal wharves:													
Unloader wharf—													
Reinforced, cylinder filler.	18			116				24					158
Mass, buttress.		235	2,477	334	328	24		1,187	250				4,835
Apron, curtain walls.		17						290	355	219			881
Reinforced, deck slab.		84		7					430	516			1,037
Reinforced, buttress.								134	250		23		407
Reloader wharf—													
Reinforced, cylinder filler.	387	1,059	1,471	1,634	884	114	192	224	5		12		5,982
Reinforced, deck slab.							2,240	824	1,041	631		1	4,757
Mass, anchor wall.						563							563
Reinforced, anchor beams.								40	745	28	7		826
Miscellaneous: Duct lines, piping, tender counterweights.											38	67	105



TABLE No. 5.—Statement of work done, Pacific terminals, July 1, 1915, to June 30, 1916.

REINFORCING STEEL PLACED (POUNDS).

	July.	August.	Septem-ber.	October.	Novem-ber.	Decem-ber.	January.	Febru-ary.	March.	April.	May.	June.	Total, fiscal year.
<b>Dry dock No. 1:</b>													
Reinforcing concrete.....	55,950	50,824	31,538	272,708	134,913	40,639	78,777	15,564	8,342	3,715	332	790	694,092
Anchoring concrete (rails).....	.....	81,513	81,513	52,163	79,147	35,000	84,373	3,593	11,667	.....	.....	.....	350,396
Storm sewer and duct line.....	.....	9,032	8,991	31,225	17,741	14,148	16,476	16,748	5,883	136	.....	.....	120,383
Duct lines and ejector pit.....	.....	.....	.....	.....	.....	.....	.....	3,660	5,903	1,520	1,360	1,430	8,875
<b>Total.....</b>	<b>55,950</b>	<b>50,856</b>	<b>125,045</b>	<b>356,036</b>	<b>231,801</b>	<b>89,787</b>	<b>179,626</b>	<b>39,565</b>	<b>26,797</b>	<b>5,371</b>	<b>1,692</b>	<b>2,220</b>	<b>1,173,746</b>
<b>Entrance pier:</b>													
Reinforcing concrete walls and piers.....	21,161	1,410	.....	3,663	.....	.....	30,172	96,870	15,141	.....	.....	.....	168,417
Anchoring wall and piers.....	.....	.....	.....	3,500	11,293	.....	92,867	31,733	7,992	7,933	.....	.....	139,393
Reinforcing deck slab.....	.....	.....	.....	23,511	4,085	26,383	.....	.....	.....	.....	.....	.....	69,904
<b>Total.....</b>	<b>21,161</b>	<b>1,410</b>	.....	<b>30,674</b>	<b>15,378</b>	<b>26,383</b>	<b>123,039</b>	<b>128,603</b>	<b>23,133</b>	<b>7,933</b>	.....	.....	<b>377,714</b>
<b>Coaling plant:</b>													
Coal pocket—													
Reinforcing walls.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23,785	.....	.....	23,785
Anchoring walls, viaduct posts and curtain wall.....	53,563	.....	.....	.....	.....	.....	168	.....	.....	5,350	6,100	.....	59,831
Conveyor system, pipe piles.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,281	.....	12,631
<b>Total.....</b>	<b>53,563</b>	.....	.....	.....	.....	.....	<b>168</b>	.....	.....	<b>29,135</b>	<b>13,381</b>	.....	<b>96,247</b>
<b>Coal wharves—</b>													
Unloader wharf—													
Reinforcing in cylinders.....	8,234	.....	.....	29,492	.....	.....	.....	1,740	.....	.....	.....	.....	39,466
Anchoring buttresses.....	7,280	16,333	17,266	4,293	.....	.....	2,800	19,366	3,500	.....	.....	.....	70,838
Reinforcing buttresses.....	.....	.....	.....	.....	.....	.....	.....	.....	31,414	.....	3,620	.....	35,040
Aprons and curtain walls.....	.....	1,180	.....	.....	.....	.....	.....	81,981	56,589	.....	.....	.....	139,750
Deck slab.....	.....	1,993	.....	.....	.....	.....	.....	.....	11,255	12,255	.....	.....	25,503
<b>Total.....</b>	<b>15,514</b>	<b>19,506</b>	<b>17,266</b>	<b>33,785</b>	.....	.....	<b>2,800</b>	<b>103,087</b>	<b>102,758</b>	<b>12,255</b>	<b>3,626</b>	.....	<b>310,597</b>



TABLE NO. 6.—Statement of work done, Pacific terminals, July 1, 1915, to June 30, 1916.  
FIXED STEEL PLACED (POUNDS).

	July.	August.	Septem-ber.	October.	Novem-ber.	Decem-ber.	January.	Febru-ary.	March.	April.	May.	June.	Total, fiscal year.
<b>Dry dock No. 1:</b>													
Gate-moving machinery.....		484			11,640	37,880	52,125	744					102,883
Gate anchorage.....					30,000	20,922	2,527						50,000
Pumping plant.....	1,230					20,344	285	9,565		8,106			30,000
Wagon-body valves.....				20,800	222,596	204,344		14,379	5,840	43,564	11,522		465,697
Bollards and cleats.....													75,305
Gratings.....	44,169								764				44,929
Storm sewer.....						496		3,720	241,396	13,196			4,712
Crane tracks.....	96	4,916	3,374	8,954	74,033	8,500	496						354,465
Keel blocks and accessories.....													716,162
Electric ducts and manholes.....						1,756	496			992			3,224
Pump well, pipe connections, and grat-ings.....													
Air and water piping.....					9,180	1,036							9,180
<b>Total.....</b>	<b>45,511</b>	<b>5,400</b>	<b>3,374</b>	<b>29,754</b>	<b>317,449</b>	<b>274,914</b>	<b>55,443</b>	<b>28,409</b>	<b>209,434</b>	<b>67,200</b>	<b>11,522</b>	<b>716,162</b>	<b>1,854,632</b>
<b>Entrance pier:</b>													
Masonry plates.....	2,304	21,782											24,086
Crane tracks and fittings.....			74,213		3,600				19,740	900			98,453
Bollards.....				1,348						17,845			19,193
<b>Total.....</b>	<b>2,304</b>	<b>21,782</b>	<b>74,213</b>	<b>1,348</b>	<b>3,600</b>				<b>19,740</b>	<b>18,745</b>			<b>141,732</b>
<b>Coaling plant:</b>													
Unloader wharf—													
Track and fastenings.....			944	13,000					39,153	45,963			85,116
Bollards, cleats, and capstan.....									4,284	3,483	2,759		24,470
<b>Total.....</b>			<b>944</b>	<b>13,000</b>					<b>43,437</b>	<b>49,446</b>	<b>2,759</b>		<b>109,586</b>
<b>Reloader wharf—</b>													
Masonry plates.....				60,208	49,100	4,972			159,972				114,280
Tracks and fastenings.....									3,213	1,071			159,972
Bollards and cleats.....							8,568						12,852
Anchorage.....				10,613	20,487	10,800	48,955	8,762	103,655	39,014			211,686
<b>Total.....</b>				<b>70,821</b>	<b>69,587</b>	<b>15,772</b>	<b>57,523</b>	<b>8,762</b>	<b>266,240</b>	<b>40,085</b>			<b>528,790</b>
<b>Conveyor system, masonry plates.....</b>	<b>500</b>	<b>3,191</b>							<b>19,708</b>		<b>2,587</b>		<b>25,986</b>
<b>Total for coaling plant.....</b>	<b>500</b>	<b>3,191</b>	<b>944</b>	<b>83,821</b>	<b>69,587</b>	<b>15,772</b>	<b>57,523</b>	<b>8,762</b>	<b>329,385</b>	<b>89,531</b>	<b>5,346</b>		<b>664,362</b>



TABLE No. 7.—Statement of work done, Pacific terminals, July 1, 1915, to June 30, 1916.

STRUCTURAL STEEL (TONS).

	July.	August.	Septem-ber.	October.	Novem-ber.	Decem-ber.	January.	Febru-ary.	March.	April.	May.	June.	Total, fiscal year.
Shops:						6.92							6.92
Building No. 3, steel storage shed.....									295.48				295.48
Building No. 29, pump and compressor house.....	168.47	89.75	84.10	81.60	38.90	15.96	0.98	1.42					481.26
Dry dock No. 1:							13.16						13.16
Gates.....								120.10	118.32		5.10		243.52
Gate machinery chamber roof.....													
Pumping plant floors.....	176.03		48.41	36.56	19.31								290.52
Crane rail girders.....					10.21								
Deck over suction chamber.....		244.50	120.48					49.04	50.00	29.32			493.40
Entrance pier, deck.....													
Coal wharves:													
Unloader wharf, deck.....	12.23				121.51				94.40				228.14
Reloader wharf, deck.....						1,062.33		435.33	21.28	21.41			1,560.35
Repair wharves and commercial pier:													
Quay wall C-D, deck.....						17.41	17.88	11.80	47.34				94.43
Quay wall D-E-F, deck.....	110.31			76.12									186.43
Pier No. 18, shed.....		308.00		473.00	320.00	829.52							1,930.52
Pier No. 18, anchorage.....									90.81	64.92			155.73
Coaling plant:													
Unloader towers, 2.....	380.00												380.00
Reloader towers, 2.....								141.00	52.40				194.00
Viaduct.....				99.00		10.00	29.00		64.00	55.00	104.00		361.00
Transformer house.....									42.50	11.00	19.50		73.00
Wharf bunker.....									94.50	155.50			250.00
Conveyor tower.....											60.00		60.00
Quarantine landing (contractor, A. P. Cray), footbridge.....	28.00	2.00											
Total.....	875.04	644.31	252.99	766.28	510.01	1,942.14	61.02	779.29	971.03	337.15	188.60		7,327.86



TABLE No. 8.—Statement of work done, Pacific terminals, July 1, 1915, to June 30, 1916.

## MISCELLANEOUS.

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Total fiscal year.
Riprap laid (cubic yards):													
Bulkhead wall, slope wall behind wharf						950						141	1,091
Reloader wharf, slope wall behind wharf									339	1,017	302		1,658
Unloader wharf, facing rock back fill	320												320
Total.....	320					950			339	1,017	302	141	3,069
Machinery erected (tons):													
Dry Dock No. 1, pumping plant,													
pumps, etc.....						10.10	64.98	210.97	104.22	40.06	4.61		434.94
Gate-moving machinery						23.69	34.80			2.54			61.03
Total.....						33.79	99.78	210.97	104.22	42.60	4.61		495.97

NOTE.—Machinery erected at coaling plant was done by contractors and no reports made.

TABLE No. 9.—Statement of work done, Pacific terminals, July 1, 1915, to June 30, 1916.  
PILES DRIVEN (LINEAR FEET).

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Total, fiscal year.
Preparing site, fill quay wall to building No. 1.....						4,800	505						4,800 505
General construction, tracks near dry dock.													
Dry dock No. 1:							375					173	375 173
For back-fill trestle.													
Bollard foundations.....									3,600				3,600
Entrance pier, fenders.....						100							1,536
Coaling plant, conveyor system, 14-inch pipe for viaduct foundations.....						485							2,497 3,000
Unloader wharf:													
Excavation, reinforcing.....	1,440	240			332					1,372	44		
Fenders.....													
Reloader wharf:													
Construction trestle and caisson supports.....		1,002	3,613	2,519	5,540	1,614			710				6,909 8,029
Anchorage wall.....													
Anchorage to support Panama R. R. tracks near old steel wharf.....													
Cofferdam, drilling, drill supports.....								4,490					4,490
Quay wall C-D, caisson guides and construction trestles.....			3,213	1,625				5,747	4,951	880			11,578
Quay wall, D-E-F, caisson guides and construction trestles.....		1,410				100							4,938
Quay wall D-E-F, fenders (repairs).....					775								1,410 775
Pier No. 18:													
Fenders.....	5,385		4,098		6,029	1,240			10,290	307			27,409
Anchorage support, center section, wall.....	4,480	20,515	15,623	4,335									44,953
Pier shed wall, land end (10-inch pipe).....		1,252					131	68					199
Quarantine landing, dolphins.....	801					1,630	6,418						2,053
Oil crib, pipe-line trestle.....													8,048
Total.....	12,105	24,479	26,547	8,479	12,646	9,969	7,429	10,305	22,611	2,619	44	173	137,407
Total, wood piles.....	12,106	24,479	26,547	8,479	12,646	9,969	7,298	10,237	22,611	1,247			135,519
Total, pipe piles.....						100	131	68		1,372	44	173	1,888
Total.....	12,105	24,479	26,547	8,479	12,646	9,969	7,429	10,305	22,611	2,619	44	173	137,407
Steel sheet piling (linear feet) unloader wharf, excavation.....				4,220	10,680	980							15,880

TABLE No. 10.—Statement of work done, Pacific terminals, July 1, 1915, to June 30, 1916.  
CAISSON OPERATIONS.

	July.	August.	Septem-ber.	October.	Novem-ber.	Decem-ber.	January.	Febru-ary.	March.	April.	May.	June.	Total, fiscal year.
<b>Unloader wharf (6-foot cylinders):</b>													
Penetration.....linear feet.	34	10	113	31					6				191
Excavation.....cubic yards.	35	10	118	33					6				202
Caissons to rock.....number.	1			4					1				6
Concrete in filler.....cubic yards.	18			116				24					158
Steel shell set.....linear feet.	45	20	100	30					25				220
Steel shell removed.....do.	30												30
<b>Reloader wharf:</b>													
Penetration—													
8-foot cylinders.....linear feet.	64	15	45	15	17	16	12						184
6-foot cylinders.....do.	993	547	99	11	10	15	15						1,083
4-foot cylinders.....do.				4	13	22	22						61
<b>Total.....do.</b>	1,057	562	144	30	40	53	52						1,938
<b>Excavation—</b>													
8-foot cylinders.....cubic yards.	120	28	84	28	29	30	22						341
6-foot cylinders.....do.	1,042	575	105	12	10	16	19						1,779
4-foot cylinders.....do.				2	6	10	11						29
<b>Total.....do.</b>	1,162	603	189	42	45	56	52						2,149
<b>Caissons to rock—</b>													
8-foot cylinders.....number.	2		1	1	1	2	1						8
6-foot cylinders.....do.	19	16	6				1						42
4-foot cylinders.....do.							1						1
<b>Total.....do.</b>	21	16	7	1	1	2	3						51
<b>Concrete in filler—</b>													
Steel shells, set.....cubic yards.	387	1,039	1,471	1,031	884	114	192	224	5		112		5,982
8-foot cylinders.....linear feet.	60	20	40	35			250						175
6-foot cylinders.....do.	473	170	65	15	30	30	30						785
4-foot cylinders.....do.				5	10		40						55
<b>Total.....do.</b>	535	190	75	55	40		120						1,015
<b>Steel shells removed—</b>													
8-foot cylinders.....do.	45	110	10										45
6-foot cylinders.....do.													120
4-foot cylinders.....do.													
<b>Total.....do.</b>	45	110	10										165

NOTE.—7 foot 6 inches and 7 foot diameter shells are included in total of 8-foot shells.  
 1 12 cubic yards in May for repairs due to damage by blasting at coftordam.

25 at 7 feet 6 inches diameter; 18 at 7 feet 6 inches diameter; 27 at 7 feet diameter.





TABLE No. 11.—Statement of work done, Pacific terminals, July 1, 1915, to June 30, 1916.  
STEAM-SHOVEL EXCAVATION (CUBIC YARDS).

	July.	August.	Septem-ber.	October.	Novem-ber.	Decem-ber.	January.	Febru-ary.	March.	April.	May.	June.	Total, fiscal year.
Sosa Hill Quarry.....	10,914	40,824	41,570	61,526	84,231	89,426	75,420	74,761	26,689	5,731			511,092
Entrance pier, dry excavation.....				1,827	1,722	1,300							3,549
Entrance basin, dry excavation.....													1,300
Reloader wharf, anchor trench.....						2,120	1,248						3,368
Coal pocket, dry excavation.....								416	832	412			1,760
Diablo Hill, borrow pit.....	3,504	48	1,832		5,400			12,012					22,796
Fuel-oil handling plant, drainage ditch.....	7,304												7,304
Total.....	21,722	40,872	43,402	61,526	91,353	94,673	76,668	87,189	27,621	6,143			551,169
Total earth.....	15,806	6,000	4,532		6,416	2,120	11,945	28,061	7,736	2,789			83,405
Total rock.....	3,916	34,872	38,870	61,526	84,937	92,553	64,723	61,128	19,885	3,354			467,764
Grand total.....	21,722	40,872	43,402	61,526	91,353	94,673	76,668	87,189	27,621	6,143			551,169

TABLE No. 12.—Statement of work done, Pacific terminals, July 1, 1915, to June 30, 1916.  
SUMMARY OF SOSA HILL OPERATIONS.

	July.	August.	Septem-ber.	October.	Novem-ber.	Decem-ber.	January.	Febru-ary.	March.	April.	May.	June.	Total, fiscal year.
Excavation:													
Earth.....	4,998	5,952	2,700		1,016		11,345	13,633	6,804	2,377			48,825
Rock.....	5,916	34,872	38,870	61,526	83,215	89,426	64,075	61,128	19,885	3,354			462,267
Total.....	10,914	40,824	41,570	61,526	84,231	89,426	75,420	74,761	26,689	5,731			511,092
Drilling.....	17,666	11,365	8,235	18,983	16,335	10,174	13,724	12,656	2,856	136			112,140
Explosives, dynamite.....	14,920	251	18,191	35,163	24,570	19,337	30,152	19,337	10,291	732			173,139
Total unit cost of excavation.....	1,6334	0.7935	0.6159	0.6858	0.5531	0.4340	0.5907	0.4031	0.4523	0.6277			
Shipment to east breakwater:													
Core rock.....	1,360	125,568	130,723	54,520	75,367	66,521	42,568	48,280	13,102	1,445			359,472
Armor rock.....	2,948	2,384	5,814	6,678	7,160	11,104	11,264	12,848	2,176	912			62,588
Total.....	3,408	127,952	136,537	61,198	82,527	77,625	53,850	61,128	15,278	2,357			421,860
Percentage, armor rock to shipments.....	60.0	8.5	13.9	10.9	8.7	14.3	20.9	21.0	14.2	38.7			

Percentage for year, 14.8.  
Unit cost for year, \$0.5719.

The deliveries shown for core rock in August and September differ from the other tables by 496 cubic yards, this amount having been transposed to agree with correct cost data.  
The above quantities and unit costs of excavation are totals and cover excavation which was wasted and all costs of inclines and other work to get out armor rock.

## ATLANTIC TERMINALS.

## CRISTOBAL COALING PLANT.

During the year Superintendent W. G. Thompson has continued in immediate charge of this work, including all construction, field engineering, and inspection contract work, and Assistant Engineer Bernard Duchscher has continued as chief mechanical and electrical inspector of the coaling plant contract work. Junior Engineer E. C. Smith, jr., resigned as inspector of steelwork on February 7, 1916. Junior Engineer R. A. Wilson, in charge of field engineering, was transferred to Gamboa on September 1, 1915, to supervise the manufacture by contract of concrete blocks for the east breakwater.

*General.*—During the year the dredging division completed dredging to elevation minus 41 a slip 250 feet wide along the unloader wharf, all of the entrance basin, and berthing space along end wharf, and approximately 80 per cent of the slip 300 feet wide along the reloader wharf. The material was pumped ashore and used for filling low places on Mindi Island and the mainland. Approximately 25,000 cubic yards of this material, being coral rock, was loaded by steam shovel from the spoil bank formed on Mindi Island and sent to Balboa, where it was used for filling back of wharves.

The caissons for the end wharf were completed in December, 1915. Much difficulty was experienced with two of the caissons under the wharf bunker. On August 25, 1915, these two cylinders collapsed, due to heavy pressure on the north side. After unsuccessful attempts had been made to drive 8-foot cylinders in their place, a 6-foot cylinder was driven on each side of the two 8-foot cylinders. After much difficulty, these four cylinders were driven in pairs, excavated, and filled with concrete, after which they were connected by a heavy steel girder, upon which rested the main floor girder. The concrete floor at the end of wharf was completed in January, 1916. The concrete decking of the reloader wharf was completed in October, 1915, and that for the unloader wharf in August, 1915. The fender system for the unloader wharf was completed in September, 1915, for the end wharf in February, 1916, and that for the reloader wharf was 75 per cent completed on May 31, 1916, the remainder having been delayed by the dredging in the reloader slip. A system of floating fenders was installed, which will breast vessels about 5 feet away from the concrete face of the docks. A trench was dug across the French Canal by a suction dredge between Dock No. 13 and the south end of the coaling plant, in which were laid two 10-inch fuel oil pipes and one 10-inch water pipe. An oil pipe was laid along each side of the plant and across the end wharf, making a complete circuit of the wharves. It is suspended by hanger bolts underneath the wharves, near the face, and has outlets at frequent intervals for supplying fuel oil to vessels lying alongside. The water pipe is supported by the viaduct structure about 10 feet above the deck of wharf and also makes a complete circuit of the plant. Leading downward from the main at convenient intervals are outlets, with a meter. There are also at intervals hose connections for fire service. The oil and water systems were completed on May 31, 1916.

The coral and rock retaining wall under the wharves was completed to about elevation plus 2 during the year. This will afford a satisfactory protection for the coal within subaqueous storage area and will

prevent wave action. The permanent standard gauge tracks were practically completed on May 31. The standard-gauge track scales at the south end of the unloader wharf were completed and adjusted, and the weigh-house was built during May. Cleaning up of the coal storage area is completed, and but little cleaning up and grading outside of storage area remained on May 31.

The installation of the permanent tracks for the stocking and reclaiming bridges on the walls south of the wharves was completed during the year. Tool houses for use of the supply department in delivering fuel oil to vessels were built on each wharf. Forces of the building division started the construction of a reinforced concrete office and storehouse for the operating force at the southeast corner of the coal plant. This building was approximately 75 per cent completed on May 31. Owing to the closing of the canal in October, 1915, and the consequent falling off of coal requirements for merchant vessels, the storage space at Mount Hope was unable to take the surplus coal, necessitating the dumping of coal from cars, loaded at the old Brown Hoist plant, into the storage space at the coaling plant, with the result that before the new plant has been completed there are approximately 85,000 tons of coal now stored there.

The foundations of the wharves consist of three hundred and twelve 6-foot-diameter steel cylinders, which were driven to hard rock, excavated, and filled with concrete, reinforced with vertical steel rails; 20,917 cubic yards of concrete, costing \$4.79 per cubic yard, not including reinforcing, were required to fill these caisson foundations. The methods employed in sinking these caissons were described in the last annual report.

The erection and riveting of the deck steel in the unloader and reloader wharves were completed by contractor J. O. Childers during July, 1915. Erection and riveting of floor steel for the end wharf were done by Panama Canal forces and were completed in December, 1915. The reinforced concrete floor slab and the girder encasement of floor girders were completed in January, 1916; 17,211 cubic yards of reinforced concrete, costing \$4.64 per cubic yard, not including forms or reinforcement, were required to complete the floors. Creosoted fender piles spaced 10 feet center to center have been driven along the face of all wharves, and a system of horizontal floating fenders has also been installed.

*Stocking and reclaiming bridges—Washington Order No. 40483.*—The operating machinery of the two bridges and the four bridge diggers was completely installed during the year. Both bridges have moved along the tracks under their own power, and all diggers have been moved along the bridges under their own power. The diggers on the south bridge have dug several hundred tons of coal which was loaded into the 10-ton trolley cars. Mr. Augustus Smith, the contractor, has supervised the breaking in of these machines and bridges, which it is expected will be ready for acceptance tests early in next fiscal year.

*Viaduct system, power house, wharf bunker, etc.—Washington Order No. 40483.*—The viaduct system was completed during the year, and 80 of the 88 cars for this plant were practically completed on May 31. Most of these cars have been run satisfactorily for several days, both light and under load. The power substation or transformer house was completed and the installation of electrical



equipment completed during the year. A trench was dug by a suction dredge across the bottom of the French Canal, between the Cristobal substation and the coaling station at the south end of the coal-storage area, in which all power cables necessary for the operation of the plant have been laid by the electrical division. The wharf bunker and conveyer tower on the end wharf were completed in May, 1916, with the exception of the installation of certain machinery and a small amount of structural steel which is to support the conveyer belts. The lighting system for night operation is entirely completed. The four sets of viaduct scales were completed and adjusted.

*Reloader towers—Washington Order No. 40483.*—The reloader towers were completed during April, 1916, except for minor fittings. Their trailers and hoppers and the hoppers under the viaduct, which feed the reloader conveyer, were also completed. The concrete aprons along the reloader viaduct trestle, which guide the coal into feeder hoppers, were completed during April. Except for certain adjustments and minor modifications, the reloader towers and their appurtenances are completed and ready for acceptance tests. Tower No. 1 has been operated and has loaded several hundred tons of coal into barges.

*General summary—Washington Order No. 40483.*—All of the equipment under this contract at the Cristobal plant is now complete and ready for tests prior to acceptance by The Panama Canal except for final adjustments, except the wharf bunker and conveyer tower and their attendant conveying machinery, some of which was installed on May 31, 1916. A committee was appointed by the Governor in May, 1916, to prepare a program of tests for the equipment under this contract and to conduct the tests.

*Four unloader towers—Washington Order No. 40587.*—The four unloader towers furnished under the above contract by the Hunt Construction Co. of New York were completely erected, and the installation of operating machinery completed during February, 1916. The first acceptance tests, under the supervision of a committee appointed by the Governor, commenced on unloader tower No. 1 on February 28, 1916, by unloading coal from the Panama Canal collier *Ulysses*, after which the collier *Achilles* was used. Certain of the tests were carried on with 600-ton barges. Some of the towers did not make the maximum capacity of 250 tons per hour required for an 8-hour run during the first trial and were subjected to a second run. These tests were concluded in March, but, owing to the fact that a number of adjustments and modifications were considered necessary to correct defects and deficiencies that developed during the tests, they have not as yet been accepted by The Panama Canal.

*Concrete blocks for the east breakwater.*—During January, 1916, a plant was installed and a force organized for the manufacture of some concrete blocks to be used for armor on the east breakwater. The pouring of concrete began on February 4 and will be completed at the end of this fiscal year. The blocks are 5 feet 3 inches cube, having 3-inch beveled edges, and contain 5.3 cubic yards of concrete. Four thousand six hundred of these blocks are being manufactured at the Cristobal coaling plant. To May 31, 3,347 blocks, containing 17,739 cubic yards of concrete, at a total cost of \$3.9377 per cubic yard, had been manufactured.

TABLE NO. 13.—*Reinforcing iron (pounds).*

	Caissons.	Floor.	Wharf bunker.	Miscel- laneous.	Total.
1915.					
July.....	93,471	95,871	.....	.....	189,342
August.....	251,819	102,605	.....	2,919	357,343
September.....	81,137	68,829	.....	67	150,033
October.....	14,463	31,028	.....	.....	45,491
November.....	32,966	19,816	.....	700	53,482
December.....	21,573	.....	.....	.....	21,573
1916.					
January.....	.....	22,557	.....	.....	22,557
February.....	.....	.....	.....	.....	.....
March.....	.....	.....	5,300	.....	5,300
April.....	.....	.....	14,979	152	15,131
May.....	.....	.....	13,520	181	13,701
Total.....	495,429	340,706	33,799	4,019	873,953

TABLE NO. 13A.—*Piles driven (linear feet).*

	Fender piles, wood.	Dolphins for port captain, wood.	Total.
1915.			
August.....	2,495	.....	2,495
September.....	6,760	1,835	8,595
1916.			
February.....	3,285	.....	3,285
March.....	2,250	.....	2,250
April.....	825	.....	825
May.....	4,160	.....	4,160
June.....	1,706	.....	1,706
Total.....	21,481	1,835	23,316

TABLE NO. 13B.—*Back fill (cubic yards).*

	Wharves.		Miscel- laneous, (dry).	Retain- ing walls (dry).	Total.
	Dry.	Wet.			
1915.					
July.....	1, 116	12, 092			13, 208
August.....	1, 908		15		1, 923
September.....				150	150
October.....	148	10, 000			10, 148
November.....		2, 470	65	260	2, 795
December.....	114	985	766		1, 865
1916.					
January.....	286				286
February.....	260		198		458
March.....	30				30
April.....	50		315		365
May.....			600		600
Total.....	3, 912	25, 547	1, 959	410	31, 828

TABLE NO. 14.—*Progress of cylinders.*

	Footing placed.	Penetration.	Footings to rock.	Concrete filler.	Reinforcing iron.	Footings complete.
1915.						
July.....	13	807	20	653	93,471	6
August.....		5		1,529	251,819	17
September.....	5	265	1	354	81,137	5
October.....		4		89	14,463	1
November.....	4	201	2	166	32,966	2
December.....		58	2	173	21,573	2
Total.....	22	1,340	25	2,964	495,439	33

TABLE NO. 14A.—*Excavation (cubic yards).*

	Caissons.		Hinman-Balboa coral.	Duct lines.	Miscellaneous.	Total.
	Earth.	Rock.				
1915.						
July.....	899	65		25	33	1,042
August.....	190	28		92	20	330
September.....	164	6		5	100	275
October.....		3.5	890			893.5
November.....	162	3	4,693		65	4,923
December.....	62	5	3,860		766	4,693
1916.						
January.....			4,473			4,473
February.....			23,555		198	23,753
Total.....	1,477	130.5	37,471	122	1,182	40,382.5

TABLE NO. 14B.—*Table showing summary of erection of wharf decking steel up to June 30, 1916.*

	Reloader wharf.		End wharf.	
	Erected.	Riveted.	Erected.	Riveted.
1915.	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>	<i>Tons.</i>
July.....	20	373		
August.....			160	120
September.....			100	60
October.....			80	110
November.....			25	40
December.....			55	85
1916.				
January.....				5
Total.....	20	373	420	420

TABLE NO. 14C.—*Tracks (linear feet).*

	Temporary track.		Perman-ent track laid.	Total.
	Laid.	Removed.		
1915.				
July.....	2,000	1,500	1,320	4,820
August.....	1,000	2,000	4,203	7,203
September.....	1,000	700	1,163	2,863
October.....	1,000	1,500	1,881	4,381
November.....	1,000	1,500	390	2,890
December.....	500	1,000	.....	1,500
1916.				
February.....	.....	300	400	700
March.....	500	.....	200	700
April.....	500	200	600	1,300
May.....	200	500	350	1,050
Total.....	7,700	9,200	10,507	27,407

TABLE NO. 15.—*Fixed iron (pounds).*

	Caissons.	Floor.	Wharf bunker.	Oil pipe line.	Miscellane-ous.	Total.
<b>1915.</b>						
July.....	40	15,164	.....	.....	.....	15,204
August.....	23,123	54,439	.....	.....	.....	79,562
September.....	11,856	35,824	.....	.....	17	47,697
October.....	2,808	19,649	.....	.....	33,228	55,685
November.....	1,748	4,858	.....	.....	.....	6,606
December.....	3,225	.....	.....	462	.....	3,687
<b>1916.</b>						
January.....	.....	.....	.....	3,920	.....	3,920
February.....	.....	.....	.....	.....	3,452	3,452
March.....	.....	.....	.....	4,718	798	5,516
April.....	.....	.....	1,958	7,304	71	9,333
May.....	.....	.....	9,341	1,269	1,635	12,245
June.....	.....	.....	.....	.....	597	597
Total.....	44,800	129,934	11,299	17,673	39,798	243,504

TABLE NO. 15A.—*Concrete (cubic yards).*

	Caissons.	Floor.	Blocks.	Wharf bunker.	Miscellane-ous.	Total.
<b>1915.</b>						
July.....	653	2,042	.....	.....	24	2,719
August.....	1,529	3,186	.....	.....	27	4,742
September.....	354	2,826	.....	.....	40	3,220
October.....	89	978	.....	.....	11	1,078
November.....	166	975	.....	.....	390	1,531
December.....	173	.....	.....	.....	15	188
<b>1916.</b>						
January.....	.....	627	18	.....	.....	645
February.....	.....	.....	2,804	.....	1	2,805
March.....	.....	.....	2,889	55	.....	2,944
April.....	.....	.....	5,443	152	26	5,621
May.....	.....	.....	6,604	117	9	6,730
June.....	.....	.....	4,102	.....	.....	4,102
Total.....	2,964	10,634	21,860	324	543	36,375

## EAST BREAKWATER.

During the year Superintendent C. C. Snedeker has continued in immediate charge of construction work, with Junior Engineer J. C. Hipp in charge of surveys and field engineering.

During the year the replacement of the trestle destroyed by the "northers" in February and April, 1915, was completed, and the remainder of the trestle to the outer end of the breakwater, including a single-track trestle on the ell, was driven. The placing of dry and wet fill was resumed and carried to completion as regards core and armor rock from Sosa Hill and the hydraulic fill. The manufacture of concrete blocks and the removal of the trestle was started. On May 31 there remained about 40,000 yards of scow dump to be placed along the harbor slope, the manufacture of 5,597 concrete blocks, and the placing of the remainder of the concrete blocks required to bring the breakwater up to its final section.

*Reconstruction of trestle.*—The redriving of the trestle which was destroyed by the 1915 "northers" was continued simultaneously on the shore connection and the breakwater proper. The shore-connection trestle reached the breakwater proper on July 28, 1915. The section on the breakwater proper was completed on September 1, 1915, to station 38 plus 05 (the point reached before the "northers"). Salvaged piles and decking material were used to a large extent in the reconstruction. A total of 1,952 linear feet of double-track and 1,702 linear feet of single-track, equivalent to 5,606 linear feet of single-track trestle, were driven, using 108,405 linear feet of piling. Table No. 16 gives the linear feet of the equivalent single-track trestle reconstructed.

The shore-connection trestle between stations 20 and 47 is known as the "floating trestle" because the piles were not driven to hard bottom. It has stood satisfactorily the test of service. This is a single-track trestle, which was driven in May and June, 1915. The two outside piles of each bent are untreated and 85 feet long. The two center piles are salvaged creosoted piles about 45 feet long, spliced with a 35-foot length of untreated pile. All piles were dapped and wooden collars 42 inches square were bolted on at proper distance from the cut-off to enable the collars, by resting on the original bottom or the blanket of coral fill, to take the greater part of the load. Each bent was required to have a theoretical ultimate bearing power of 45 tons. In some cases it was necessary to drive a fifth pile to get the bearing power required. Coral sand and rock to the amount of 134,502 cubic yards was pumped in along the trestle to elevation minus 15 in order to give it lateral stability and increased bearing power. A profile of the elevation of the ends of the caps was made monthly and showed an average settlement of about 1 inch, with a maximum of 5 inches per month. The settlement was fairly even, and was easily taken care of by shimming under the caps and blocking up the stringers.

*Construction of new trestle.*—The construction of the double-track trestle for the breakwater proper from station 38 plus 05 "C" to the outer end was completed on October 7, 1915. The best month's work was 1,614 linear feet of double-track trestle. The previous record on the Isthmus was made in August, 1914, on the east breakwater, when 1,591 linear feet were built. A single-track trestle 444

feet long was built for the ell. A total of 1,644 linear feet of double track and 444 linear feet of single-track, equivalent to 1,866 linear feet of double-track trestle were driven, using 101,530 linear feet of piling. Table No. 17 gives the number of linear feet of the equivalent double-track trestle constructed.

*Dry fill.*—The dumping of Sosa Hill rock was resumed on July 29, 1915, when the shore connection of the trestle was completed. In November, 1915, an extension of the breakwater shoreward 1,226 feet was authorized. The total authorized center line length, including the ell, 225 feet long, at the outer end, is 6,741 feet. The inner end is 4,500 feet from the shore at Coco Solo point. The core rock fill was completed in March, and the Sosa Hill quarry was closed down. Table No. 18 gives the quantities of armor and core rock which were handled. The rock was plowed off the Lidgerwood cars into place.

The percentage of armor rock recovered from quarry operations was not sufficient to armor the breakwater. This deficit is being met by the manufacture of concrete blocks at four different points. The cubes weigh about 5.6, 10.6, 18, and 25 tons, respectively. It was found practicable to plow a considerable proportion of them from Lidgerwood cars onto the sea slope of the breakwater. A small amount of core rock from Sosa Hill and 1,250 cubic yards of soft rock from the Mount Hope borrow pit was dumped on the blocks from time to time to form a "cushion" for the further dumping of blocks. Derrick barges are being used to place blocks in the top section. Table No. 19 gives the quantities of concrete blocks plowed and placed.

*Wet fill.*—It was not possible to make the base of the breakwater sufficiently broad by dumping rock from the trestle. When the core rock fill was completed, the toe of the slope on the harbor side was therefore extended by dumping hard dredged material from scows and by dumping coral rock and sand from a borrow pit near the shore at Coco Solo. The scow material was obtained from the excavation near the Cristobal coaling plant and amounted to 145,257 cubic yards. There were no charges against the breakwater for this material. The hydraulic fill of coral rock and sand was pumped into place by a suction dredge, assisted by two electrically driven relay pumps located along the trestle pipe line. The suction dredge pumped into the breakwater proper a total of 155,036 cubic yards. In addition, 134,502 cubic yards was pumped in along the shore connection trestle to give it lateral stiffness and protection against heavy seas. This work was done by the dredging division. Table No. 20 gives quantities of the hydraulic fill. The quantities given from July to December were measured in the borrow pit; those for January to March were measured in place in the fill.

*Production of concrete blocks.*—In January, 1916, the east breakwater subdivision was authorized to manufacture 40,050 cubic yards of concrete blocks at Coco Solo. The blocks were to be cubes of run-of-bank Chagres gravel, measuring 6 feet 3 inches on a side, and containing 9 cubic yards each, the mixture being about 1 to 4½. Accordingly, preparations were made to use Coco Solo yard as a manufacturing plant as soon as the dumping of Sosa Hill rock should be completed. There were 4,015 feet of track laid to make a storage yard for green blocks; 1,400 cubic yards of soft rock and 720 cubic

yards of gravel ballast were used for these tracks. Tracks Nos. 3 and 6, measuring a total of 2,540 linear feet, were removed, and tracks Nos. 2 and 7 were raised about 18 inches, using 925 cubic yards of gravel ballast, in order to facilitate the handling of gravel to the mixer. A portable concrete plant, using a one-half-yard batch mixer, was erected on a car, and 180 forms were made. A complete lighting system for the yard was installed, in order to be able to work 16 hours per day. Table No. 21 gives the monthly output of concrete blocks.

*Miscellaneous.*—Work was continued until October 16, 1915, salvaging the trestle material which was washed up on the shores of Limon Bay by the 1915 "northers." There were recovered 271,056 feet b. m. of stringers, caps, ties, and filler blocks; 3,165 linear feet of creosoted piling, and 21,490 linear feet of untreated piling. The greater part of this material was used in the reconstruction of the trestle. The material which was not serviceable for the original purpose was sawed up in the log sawmill, making braces, ties, filler blocks, shimming blocks, and car stakes. There were 1,257,084 feet b. m. of lumber sawed. In March, 1916, work was begun tearing up the temporary trestles on the ell and the outer end of the breakwater. Approximately 3,500 linear feet of single-track trestle have been removed. The log sawmill has sawed 194,302 b. m. feet from this material. The total output of the sawmill was, therefore, 1,451,386 feet b. m. In addition, it cut up 9,220 feet b. m. of lumber which was used as forms for concrete blocks. A small force was engaged regularly in the maintenance of the temporary trestle. The work has cost for labor, material, and all charges \$0.0392 per cubic yard of dry fill dumped. The maintenance of the Margarita main line and the Coco Solo yard tracks was done by the forces of the Panama Railroad. The Coco Solo dock was reinforced with 1,491 linear feet of piling in order to be able to handle the 25-ton concrete blocks; 715 feet of 1-inch and 319 feet of 1¼-inch pipe were laid for water and compressed air connections to the dock. There were placed in the tail track alongside the dock 231.5 cubic yards of core rock and 80 cubic yards of gravel ballast. Six hundred and seventy-five linear feet of piling were driven in dolphins; 391 linear feet of track were laid for the sawmill yard; 1,273 feet of 3-inch and 3,610 feet of 2-inch water main were laid on the trestle; and 808 linear feet of piling were driven in the foundations for Relay Station No. 2 and the building erected. The buildings for Relay Stations Nos. 1 and 2 were torn down in April, the hydraulic fill having been completed. One 60-h. p. and one 30-p. h. motor were installed in the sawmill.

#### WEST BREAKWATER.

*Maintenance.*—In 1915, the months of October–December, inclusive, 2,805 cubic yards of armor rock and 7,252.4 cubic yards of concrete blocks were placed on the west breakwater by derrick barge No. 157 in repairing the damage done by the 1915 "northers." The cost was \$5.45 per cubic yard for armor rock and \$3.5907 per cubic yard for concrete blocks. Six hundred and eighty linear feet of piling were driven in dolphins as a mooring station for the derrick barge. There is still required about 10,000 cubic yards of armor to complete the repairs.

TABLE NO. 16.—*Trestle reconstruction.*

Date.	Linear feet.
1915.	
To June 30.....	4,875.8
July.....	3,484.0
August.....	2,050.0
September.....	72.0
1916	
To June 30.....	10,481.8

TABLE NO. 17.—*Trestle construction.*

Date.	Linear feet.
1915.	
To June 30.....	9,498
July.....	
August.....	
September.....	1,578
October.....	66
November.....	141
December.....	81
1916.	
To June 30.....	11,364

TABLE NO. 18.—*Dry fill in place—plowed off Lidgerwood cars.*

Date.	Core rock.	Armor rock.	Total.
1915.		<i>Cubic yds.</i>	<i>Cubic yds.</i>
To June 30.....	318,778	2,368	321,146
July.....	752	992	1,744
August.....	26,176	6,732	32,908
September.....	30,685	7,776	38,461
October.....	51,911.67	4,988	56,899.67
November.....	76,974.66	5,776	82,750.66
December.....	68,791	11,228	80,019
1916.			
January.....	43,680	11,168	54,848
February.....	45,407	12,640	58,047
March.....	16,535.50	2,816	19,351.50
April.....	1,666	1,008	2,674
May.....	680		680
Total.....	682,036.83	67,492	749,528.83

TABLE NO. 19.—*Placing concrete blocks.*

Date.	Placed by derrick barge.	Plowed off Lidgerwood cars.	Total.
1915.		<i>Cubic yds.</i>	<i>Cubic yds.</i>
November.....	(1)	24.6	24.6
December.....	3,135.2	2,164.5	5,299.7
1916.			
January.....	5,606.8	3,270.3	8,877.1
February.....		9,122.4	9,122.4
March.....		14,814.3	14,814.3
April.....	8,997.2	13,150.6	22,147.8
May.....	25,018.0	6,866.0	31,884.0
June.....	23,262.6		23,262.6
Total.....	66,019.8	49,412.7	115,432.5

<sup>1</sup> Test blocks.



TABLE NO. 20.—*Hydraulic filling.*

Date.	Cubic yards.
1915.	
To June 30.....	252,319
July.....	25,018
August.....	29,882
September.....	37,057
October.....	52,745
November.....	24,417
December.....	51,639
1916.	
January.....	18,800
February.....	18,230
March.....	31,750
Total.....	541,857

TABLE NO. 21.—*Concrete-block production.*

Date.	Number blocks.	Cubic yards.
1916.		
February.....	113	1,017
March.....	593	5,337
April.....	844	7,596
May.....	1,023	9,207
June.....	1,071	9,639
Total.....	3,644	32,796

## MANUFACTURE OF CONCRETE BLOCKS AT GAMBOA.

A contract was entered into on August 2, 1915, with Messrs. J. A. Walker and W. A. Torbert, under the firm name of Walker & Torbert, for the manufacture of 10,000 concrete blocks, measuring 7 feet on a side, containing 12.3 cubic yards, and weighing about 50,000 pounds. The right was reserved to increase or decrease the number by 20 per cent. Junior Engineer R. A. Wilson has acted as inspector on the manufacture of these blocks during the year. Thirteen bids were received on the specifications which were issued, varying from \$4.7355 to \$14.63 per block. Under the specifications The Panama Canal was to furnish the gravel and cement free of charge, delivered at the point of manufacture. The contractor was allowed the free use of equipment and second-hand material. The mixture under which the first 1,500 blocks were made was cement and run-of-bank gravel in a proportion of about 1 to 6. The remaining blocks have been made of a mixture of 1 to about  $4\frac{1}{2}$ .

Award was made to Messrs. Walker & Torbert, the lowest bidders, at \$4.7355 per block. The layout of the contractor's plant is shown on Plate No. 91. It consists of a wooden trestle, from which was dumped the gravel to form a stock pile underneath and on one side. The mixing plant consisted of three half-yard cube mixers, and was mounted on two flat cars, running on parallel tracks 14 feet center to center along one side of the trestle. The mixers were elevated a sufficient amount to discharge directly into chutes commanding forms 40 feet from the mouth of the mixers. Each mixer was fed by gravity from a 6-yard hopper. The hoppers were filled by a

locomotive crane of the type known as a "ditcher," mounted on a car which ran on the trestle over the storage pile. The trestle was 12 feet from the mixer track and 14 feet above it. The gravel was discharged into the measuring hoppers by a sliding gate, where it was mixed with cement. A second system of sliding gates fed the mixture into the mixers. Cement was transferred from box cars, running on the mixer track, to the operating platform above the mixers by a Decauville car running on an inclined track at each end of the mixer installation, operated by a hoisting engine. The cars carried 10 sacks of cement and averaged a trip a minute. The empty cement sacks were cared for on the operating platform until the end of the day's work. Steam was supplied for the mixers and the hoisting engine by an old French locomotive, by which, also, the entire mixing plant was moved along the tracks. Portable wooden forms of seven-eighths of an inch material were used on permanent platforms of seven-eighths of an inch material. Plate No. 92 shows their construction. Two corners diagonally opposite are nailed solid; the other two corners furnished with wedge blocks are free to move. The two pieces of forms forming the four sides are placed on the 9-foot square platforms with the chamfer strips for the bottom nailed to the platform with the outside edge forming a 7-foot square. The forms are wedged up to the chamfer strips, and the side and top chamfer strips are then placed. To remove the form, the wedges are taken out, corners spread, and the entire form lifted; 180 forms and 394 bases were used. The forms, placed in four longitudinal rows, were grouped in sections of 12 files each, forming blocks of 48. In pouring blocks, a gap of 48 bases was left between each group of 48 blocks, and the forms are shifted back and forth thereon. Sometimes the sections or groups have been less than 48, but the latter has proved the most economical arrangement.

In casting, a recess is molded on two opposite sides by attaching boxes 15 inches long, 8 inches deep, and 3 inches thick thereto. These recesses are for the lifting hooks. It was found satisfactory to lift the blocks from 72 to 96 hours after pouring for transfer to the storage pile. The hooks used for lifting these 25-ton blocks are shown on Plate No. 93. They were designed for this work by the contractors and proved to be very satisfactory, indeed. Each pair of hooks weighs about 2,600 pounds and has a clear width when open of about 7 feet 2 inches. The channel iron, which keeps the jaws from closing to less than 6 feet 7 inches, is so arranged by a notch and pin that when the hook drops over the top of the block and the jaws are opened to clear the block, the channel holds them open about 7 feet 2 inches, which enables the hook to be lifted off.

The contractors used two 40-ton Bay City cranes with outriggers in handling these blocks, and secured better balance by an additional load on the coal and water tanks of about 5 tons of pig iron. The blocks were required to be held in storage before shipment to Coco Solo for not less than 25 days. The first block was cast on October 9, 1915, and on December 20, 1915, the contractors were notified that advantage would be taken of the offer to require an increased output to 75 blocks per day, and that they would be called upon to deliver 20 per cent (or 2,000) additional blocks.

The Chagres River gravel, except in a few instances, ran quite uniform. With the richer mixture it has proved entirely satis-

factory. The principal difficulty has occurred at times when the dredge commenced a new cut, when deliveries contained an undue amount of sand, together with wood and other foreign substance.

The largest number of blocks mixed in one day was on March 30, when 101 blocks, containing 1,242 cubic yards of concrete, were poured in 11½ hours, or an average hourly output of 108 cubic yards, or 36 yards per mixer per hour.

TABLE NO. 22.—Walker and Torbert contract—Rate of manufacture of concrete blocks, and the total to date.

[Manufacture began Oct. 9, 1915.]

Date.	Blocks poured.	To date.	Cubic yards.	To date.
1915.				
October.....	412	412	5,068	5,068
November.....	775	1,187	9,532	14,600
December.....	513	1,700	6,310	20,910
1916.				
January.....	1,108	2,808	13,628	34,538
February.....	1,482	4,290	18,229	52,767
March.....	1,909	6,199	23,481	76,248
April.....	1,647	7,846	20,258	96,506
May.....	1,695	9,541	20,849	117,354
June.....	1,606	11,147	19,754	137,108
Total.....	11,147	.....	137,109	.....

TABLE NO. 23.—Rate of shipment.

[First shipment November, 1915.]

Date.	Blocks shipped during month.	Shipped to date.	Yardage.	To date.	On hand.
1915.					
November.....	274	.....	3,370	.....	.....
December.....	776	1,050	9,545	12,915	650
1916.					
January.....	700	1,750	8,610	21,525	1,058
February.....	741	2,491	9,114	30,639	1,799
March.....	740	3,231	9,102	39,741	2,968
April.....	1,131	4,362	13,911	53,653	3,484
May.....	1,610	5,972	19,803	73,456	3,569
June.....	806	6,778	9,914	83,370	4,369
Total.....	6,778	.....	83,369	.....	.....

#### PIER NO. 7 AND OTHER WORK.

The work performed by the subdivision of the engineer of docks during the year, including both design and construction work, was continued under the supervision of Mr. T. B. Monniche, engineer of docks, who was in immediate charge of office and design, and was assisted by Supervisor C. A. Nelson on construction.

At the beginning of the year the principal work underway on Pier No. 7 was the substructure, the condition of the various items being as follows:

- (a) Driving steel cylinders, 92 per cent complete.
- (b) Excavation of cylinders, 85 per cent complete.
- (c) Concreting of cylinders, 76 per cent complete.

During August and September each of the above items of work was completed. There were put in place 1,840 linear feet of steel cylinders, making a total of 22,065 linear feet; 2,077.9 cubic yards of material were excavated, making a total of 14,174.6 cubic yards, and 5,525.7 cubic yards of concrete were poured into the cylinders, making a total of 22,644.4 cubic yards. The entire substructure was completed on September 7th.

The cylinders are 6 feet in diameter, reinforced at the top by eight standard 70-pound and 56-pound rails, four of which extend down to elevation minus 68, and the others down to elevation minus 22. The eight rails extend up above the cylinders to elevation plus 11, and are embedded in the concrete encasement of the girder connections for the purpose of providing rigid bracket connections between the floor system and the cylinders. By this arrangement the ability of the pier to resist lateral forces is greatly increased. The excavation of the cylinders was performed by the use of star drills and the bailing by pulsometers.

The concrete mixing plant used for the cylinders is shown by Plate No. 19 and also by Plate No. 89. A half-yard mixer with hoppers was mounted on a flat car. Cement was supplied from a box car on the same track as the mixer. A pan car running on a single track inclined runway carried cement in bags from the cement car to the mixer, the pan car being operated by a donkey engine mounted on a flat car carrying the concrete mixer. Run-of-bank gravel was supplied from a barge alongside the pier by a locomotive crane equipped with a clamshell bucket. No rock was used in the concrete. The mixture of cement and run-of-bank gravel was in the proportion of 1 to 4. The cost per linear foot of steel cylinder in place, including material, was \$9.48; the cost per cubic yard of material excavated, including pumping, plant charges, etc., was \$5.47, and the cost per cubic yard of concrete in place, including reinforcing, \$5.31, and not including the cost of reinforcing, \$3.99. The cost of driving was high, which was due to the large amount of sand encountered making the driving slow and expensive. The average depth below sea level to the base of the cylinders is about 91 feet, the maximum depth being 130 feet. The high cost of excavation was due to the great amount of leakage, through seams in the rock, which allowed water to enter at the bottom of the cylinders. The seams in the rock made it necessary to seal 75 per cent of the cylinders, for which the cost of mixing and pouring concrete was as high as \$2.93 per cubic yard, whereas the unit cost of the balance of the concrete work in the cylinders was 42 cents per cubic yard, and the combined total unit cost of mixing and placing concrete for the cylinders was 64 cents. The total cost of the substructure was \$406,794.90.

*Floor system.*—The setting of 210 steel pedestals to receive the floor system was completed on September 20, 1915. The erection of the floor steel was started by the American Bridge Co. on July 24, 1915, and the erection of the total weight of 11,447,991 pounds was completed on October 28, 1915. All cross girders and main longitudinal girders were designed as continuous girders after a complete solution of all stresses had been made. The contract price for the fabrication, delivery, and erection of the floor steel was \$0.0227 per pound. The total cost of the steel floor system in place, including the cost of all work performed by the subdivision of the engineer of

docks and by other divisions, was approximately \$280,872.61. This figure includes the costs of pedestals, crossties, bumping posts, gratings, pipe, mooring bits, and miscellaneous material for the fender system.

*Reinforced concrete floors.*—The pouring of concrete for the floor was started on October 14, 1915, and completed on February 1, 1916, a total of 16,600 cubic yards of concrete being used. Run-of-bank gravel was used throughout for the floor, the mixture being 1 to 4. The total cost of the reinforced concrete floor was \$145,490.93, which, for the 16,600 cubic yards used, amounts to a unit cost of \$8.78 per cubic yard, the reinforcing costing \$2.42 per cubic yard, and the forms \$3.50 per cubic yard. Due to the shape of the forms used for the girders, it is estimated that 4,900 cubic yards of concrete were saved. If this amount be added to the actual quantity of concrete poured, the unit cost of the reinforced concrete floor would be reduced from \$8.78 to \$6.78 per cubic yard. The total cost of the floor was approximately \$480,622.61.

*Shed.*—It was expected that the pier shed would have been completed by March 15, 1916. Serious delays, however, have been caused by present shipping conditions, which have retarded the delivery of steel for more than six months. All work which was not affected by the delay in the shed erection has progressed satisfactorily. About 10 per cent of the steel for the shed was not delivered on May 31. The erection of the shed should be complete by June 30.

Approximately 4,736,600 pounds of steel will be contained in the shed, which at a unit price for manufacture of \$0.02309 per pound, will cost approximately \$101,055.70. The erection of the shed is being performed by Panama Canal forces at an estimated cost of \$7.50 per ton. The total cost of erection is estimated at \$20,000, and the shed steel in place at approximately \$125,000. The contract for furnishing and erecting the tiling for the roof of the shed for Pier No. 7 was awarded to the American Cement Tile Manufacturing Co. in August, 1915. There have been manufactured 1,712 squares of tiling for pier No. 7, for which the contractor will be paid approximately \$30,130, including erection, and 930 squares of tiling have been manufactured for work other than Pier No. 7, for which the contractor will be paid approximately \$10,950, which does not include the cost of erection, as this work is being done by Panama Canal forces. All cement and sand for use in the manufacture of the cement tiling is being furnished by The Panama Canal. The sand used is washed Chagres River sand. The type of doors selected for use on Pier No. 7 is that furnished by the J. Edward Ogden Co., to whom the contract for 80 side doors, 2 end doors, and 40 swing columns was awarded at a total price of \$71,988.80, the contractor to perform the work of erection.

*Miscellaneous.*—Approximately 280,000 paving brick have been laid on the floor of Pier No. 7. This constitutes 20 per cent of the work to be done. The installation of water piping and electrical conduit is progressing satisfactorily and should be completed by September 1. The general layout of Pier No. 7 is shown by Plate No. 88, "Pier No. 7, General Plan, Elevations and Sections."

*Other work than on Pier No. 7.*—Borings have been made on the site of the proposed Pier No. 6, that indicate that the character of the

material to be met with is essentially the same as for Pier No. 7, although the quantity of sand to be driven through is somewhat greater. Borings were started on February 9, to ascertain conditions to be met with in extending the mole. Twelve holes have been drilled out of a total of 53 to be made. No dredging has been performed for this subdivision during the fiscal year. It has been recommended, however, that approximately 53,000 cubic yards of material be dredged from the slip between Piers Nos. 7 and 8, so that the mud line may be brought down to elevation minus 41 over this area. The manufacture of 4,000 concrete blocks for use on the east breakwater was started on February 7, and completed on May 18. The blocks measure 4 feet 3 inches on a side and contain approximately 2.8 cubic yards each, making a total quantity of 11,200 cubic yards. In pouring the concrete blocks the same concrete mixing plant was used as was used for the floor system of Pier No. 7. Use was made of three-sided forms, the fourth side of the block coming against the oiled surface of an adjacent block. The unit cost of manufacturing was approximately \$3.66 per cubic yard or \$10.23 per block.

*Additional facilities for the Cristobal terminal piers.*—During the months of July, August, and September considerable study was made with the end in view of developing a consistent plan whereby the congestions in track yards and traffic in the vicinity of the Cristobal piers might be relieved. The plan first considered was based on the use of a viaduct crossing the tracks on Roosevelt Avenue. This would effectively decrease the interruptions to traffic caused by the constant switching on the mole, but would be costly and somewhat slow in development and principally for these reasons the scheme was abandoned. A new layout of tracks was then proposed having as its principal feature a new track yard built on a fill behind the United Fruit Co. office building and the Cristobal fire station, this yard to have sufficient capacity to accommodate approximately 135 cars. By connecting Dock No. 9 and Pier No. 8 with the new yard, the removal of the tracks crossing Roosevelt Avenue would be made feasible and the interruption to traffic removed. This plan met with approval, and work was started in making the new fill on March 15, 1916. The material used in the fill was soft rock from the Mount Hope borrow pit, of which 58,010 cubic yards were used in the fill, the last train load being dumped on May 17, 1916. As yet no armor rock has been placed on the mole. It is intended to supply same from surplus rock now on the north side of Cristobal mole, but since a considerable quantity of paving brick and other material are stored on the area in question and a storehouse and carpenter shop are also located there, authority was obtained to postpone the armoring until the above material and buildings could most conveniently be removed. The laying of tracks for the new yard will be started soon after the arrival of the material from the United States, which should be about June 15. Plate No. 90 shows the general arrangement of the new fill and track yard which is estimated to cost \$84,422. In connection with the new plans for the new track yard certain other facilities, also shown on Plate No. 90, were proposed and approved. A new office building to cost approximately \$85,000 has been started close to Dock No. 9 and just outside the customs line. Adjacent to Dock No. 9 a local freight and baggage and specie house will be erected, and on the concrete mole between Pier No. 8 and Dock No.

9 a building for use as an electric charging station and machine shop, sail loft, tool rooms, etc., will be built. A launch house for the port captain's launches will be built on the boat landing just below the electric charging station and a garbage house will be provided at the shore end of Pier No. 8. A new road layout providing for an extension of the roadway to Pier No. 7, and certain new roads in the vicinity of Dock No. 9 and Roosevelt Avenue has also been approved.

## GENERAL.

The expenditures of the division of terminal construction for the first 11 months of this fiscal year amounted to \$5,526,652.37.

The average number of employees during this period was 233 gold and 2,478 silver.

The following is a list of drawings accompanying this report:

Plate No.	Drawing No.	Description.
83	3022-1	Dry Dock No. 1, Balboa, assembly and detail for cast-iron keel blocks.
84	3022-2	Dry Dock No. 1, Balboa, general layout and details of bilge-block slides, wall brackets, and nosing.
85	3022-3	Dry Dock No. 1, Balboa, details of blocking system.
86	3022-4	Dry dock No. 1, Balboa, general layout and details of blocking system.
87	3021-13	Dry Dock No. 1, Balboa, snubbing post and bollards for dry dock and entrance pier.
88	X-11069	Pier No. 7, Cristobal, general plans, elevations and sections.
89	11916	Pier No. 7, concrete mixing plant for cylinders.
90	3604-5	Cristobal terminal piers, general plan, Atlantic terminals.
91	M-5024-6	Sketch No. 1. General plan concrete block plant, Walker & Torbert contract.
92	M-5024-5	Sketch No. 2. Wooden forms for 7-foot concrete blocks, Walker & Torbert contract.
93	M-5024-4	Sketch No. 3. Tackle for handling 25-ton concrete blocks, Walker & Torbert contract.

Respectfully submitted.

H. H. ROUSSEAU,  
*Civil Engineer, United States Navy,*  
*Engineer of Terminal Construction.*

Maj. Gen. GEO. W. GOETHALS, United States Army,  
*Governor, The Panama Canal, Balboa Heights, Canal Zone.*

## SUPPLEMENTAL REPORT, ENGINEER OF MAINTENANCE.

The following report of operations during the month of June continues the record of operations of the terminal construction work to the close of the fiscal year:

### ATLANTIC TERMINALS.

*East breakwater.*—During the month 51 cubic yards of run-of-bank rock from Sosa Hill were placed in the breakwater, and 2,548 concrete blocks—23,262.6 cubic yards—were placed in the breakwater by the derrick barges. Eight hundred and thirty-six blocks—10,274.4 cubic yards—were obtained from the output of the contractors, Messrs. Walker & Torbert, at Gamboa; 1,058 blocks—9,522 cubic yards—from the output of the block-casting plant at Coco Solo, and 654 blocks—3,466.2 cubic yards—from the output of the block-casting plant at the Cristobal coaling station. Twenty thousand seven hundred and fifteen yards of coral rock and 2,560 cubic yards of blue rock, total 23,275 cubic yards, excavated by the dredge *Marmot* working at the Cristobal coaling station, were dumped from scows on the harbor side of the breakwater. The operations of the concrete-block-mixing plant continued 12 hours per day from June 1 to June 26, pouring 880 blocks—7,920 cubic yards. On June 27 the plant started on a 16-hour per day working basis and during the last four days of the month poured 191 blocks—1,719 cubic yards. Total blocks poured for the month, 1,071—9,639 cubic yards—making a grand total to July 1 of blocks manufactured at Coco Solo of 3,644—32,796 cubic yards. Salvaging the trestle continued. A total of 7,400 linear feet had been salvaged at the close of the month. The sawmill sawed 125,959 feet b. m. of lumber from the salvaged material.

*Concrete-block contract.*—During the month 1,606 blocks—19,754 cubic yards—were cast, making the total number manufactured to July 1, 11,147—137,108 cubic yards—and leaving 853 blocks—10,492 cubic yards—to be cast. There were used in the manufacture of blocks at Gamboa during the month 107,510 bags of cement and 18,548 cubic yards of gravel. The average mixture for the month was 1 to 4.9, or 5.45 bags of cement per cubic yard of concrete. The daily average number of blocks cast during the 26 days of the month on which the contractor worked was 61.8. The average rate of shipment of blocks to the east breakwater was 31 per day. The comparatively lower rates of manufacture and shipment against corresponding rates for previous months was occasioned by heavier repairs to equipment. The contract with Messrs. Walker & Torbert was terminated at the close of work on June 30, and the loading of the blocks remaining in storage, 4,369 in number, was placed under the supervision of the superintendent of construction of the east breakwater. The manufacture



of the yardage remaining under the Walker & Torbert contract was transferred to the Coco Solo block-casting plant. The average force employed during the month was, gold men, 8; silver men, 130; total, 138.

*Cristobal coaling plant.*—The fender system for all wharves was completed. All concrete work pertaining to the coaling station was completed. The manufacture of the remaining authorized yardage of concrete blocks for the east breakwater, or such part thereof as may be required, was transferred to the Coco Solo block-casting plant on June 26. At the time work was stopped, the coaling station forces had manufactured 4,121 blocks of the total authorized number of 4,600. Dredging in the reloader slip by the *Marmot* continued. The contractor under Washington Order 40483, Mr. Augustus Smith, continued work on the various units of his contract. Tests on the stocking and reclaiming bridges were started June 27, and propelling tests were made with reloaders 1, 2, 3, and 4 on June 30. Under item 12-A, including viaduct, conveying system, bunker, etc., the following work was performed:

Approximately 16,800 pounds of structural steel were placed for the conveyor trusses between the tower and wharf bunker, making this item about 90 per cent complete. The conveyor belt structure was about 95 per cent completed. The bunker conveyor was about 85 per cent completed. Plank footwalks were about 25 per cent completed. Doors in the tower were installed but not completely finished. All pipe railing was erected. Erection of the six booms for the bunker chutes was started. The structural parts of the wharf bunker and tower were about 85 per cent completed; the mechanical equipment 30 per cent completed, and the electrical equipment about 98 per cent completed. Tests were run on the conveyor car system.

The forces of the contractor under Washington Order 40587, unloader towers, the Hunt Construction Co., were engaged during the month in adjusting the engines, completing all the modified 50-ton hoppers, and improving the worm shaft bearings of the driving trucks, and in making adjustments in the various parts of the tower propelling gears. A retest of unloader tower No. 4 was made on June 21.

At the close of business June 30 the construction force was disbanded largely by transfer of employees to the operating force of the plant, a few transfers to other divisions, and three resignations.

#### PACIFIC TERMINALS.

*Excavation.*—Four hundred and one cubic yards of excavation were made for the railroad track scales near Building No. 29; 144 cubic yards were excavated for permanent drains to shops, and for bollards at Dry Dock No. 1. The greater part of the filling and embankment done in grading at the coal pocket, shops, and wharves was performed by the division of municipal engineering.

*Dry Dock No. 1.*—One hundred and thirty-seven cubic yards of concrete were placed in grouting in recess covers, fixed irons, and duct lines. Pipe piles were driven to prevent settlement of the

bollards which had been placed on earth foundations. The pumping machinery in Building No. 29 received a coat of bitumastic solution and enamel. Cast-iron keel blocks were set in the dock floor, and about one-third of them grouted in. A temporary blocking system was installed, and on June 27 the dredge *Corozal* was taken into the dock, where it underwent repairs until July 1. Four hundred and eighty linear feet of horizontal fenders were made for the entrance pier.

*Bulkhead wall.*—The slip at Dock No. 17 was dredged to finished depth and the pontoons and landing bridges were installed complete. The slope behind Dock No. 19 was ripped and the area in the vicinity of the dock was graded. Rat-proofing work was performed by sloping off with concrete the tops of the caissons.

*Pier No. 18.*—Rat-proofing work for this pier, similar to that performed for the bulkhead wall, was started.

*Permanent shops.*—One thousand five hundred and two cubic yards of gravel and 4,089 cubic yards of earth were used in ballasting tracks and grading. The walls, structural steelwork, window frames, and fixtures of Building No. 29 were painted and all scaffolding removed.

*Balboa coaling plant.*—One thousand linear feet of horizontal fenders were made up for the unloader wharf and about one-half of this amount was attached to the dock. Excavation for the track scales was practically completed. Eight concrete blocks were placed in the subaqueous coal pocket where the rip-rap wall had been destroyed. The westerly retaining wall of the coal pocket was completed. In grading the area between the coal pocket and the reloader wharf there were used 685 cubic yards of gravel and 718 cubic yards of earth. The concrete work on the wharf bunker being performed by the building division was 95 per cent completed. Seven hundred and ninety-seven linear feet of horizontal fenders were made up and stored in the coal pocket for future emplacement. The fitting of bearings and brasses of the hoist engines of the unloader towers was completed. The canopy protection for the stair landing on the water side of each tower was erected and the modification of the 50-ton hopper of unloader tower No. 6 was begun. Shakedown tests were completed on the towers, and the only exceptions noted during the same was the jamming of the duplex valves. The engines of the unloader towers were run light for general observation. Hand railings were placed around the hoist engines in both towers, and overhauling the brakes and worm gears of the traveling trucks of tower No. 6 was started. On the reloader towers the traversing machinery of tower No. 5 was installed; the 50-h.p. motor was erected in place in each tower; the general work of cleaning and painting machinery was continued. Seventy-five per cent of the wooden walkways was laid and the window sash were 75 per cent installed. Extra bracing for the operators' cabs was 60 per cent completed. All rheostat supports were installed in the machinery houses. The total amount of steel erected in the viaduct at the end of the month was 432 tons. Fifty per cent of the creosoted wood ties were placed and bolted. The steel ties were retouched with red lead and given first and second field coats of paint. In the transformer house the concrete floor at the viaduct level, the 8-inch floor at the wharf level, and the duct

across the south end of the house were poured. The hy-rib in place was given the scratch and finish coats of plaster. Window sash and glass were installed complete. Erection of the 440-volt switchboard was 5 per cent completed. The oil switches behind the board were installed and bus-bar supports were mounted and insulators installed. The scale house was plastered complete and the window sash and glass installed. Forty per cent of the exposed steel had been retouched with red lead by the contractors and the first coat of field paint was 25 per cent completed on the wharf bunker. Concrete footings around the conveyor tower were completed, and the contractors installed all of the window sash and 20 per cent of the glass in this structure.

*J. Edward Ogden Co. contract for doors for Pier No. 18.*—Riveting of the sheeting was completed with the exception of one end door. Erection of the housings for all side and end doors was completed. The 32 doors on the south side of the pier were completed on June 10, and the 32 on the north side on June 17, making complete erection of 64 doors out of a total of 68. Erection of the four end doors was 70 per cent completed.

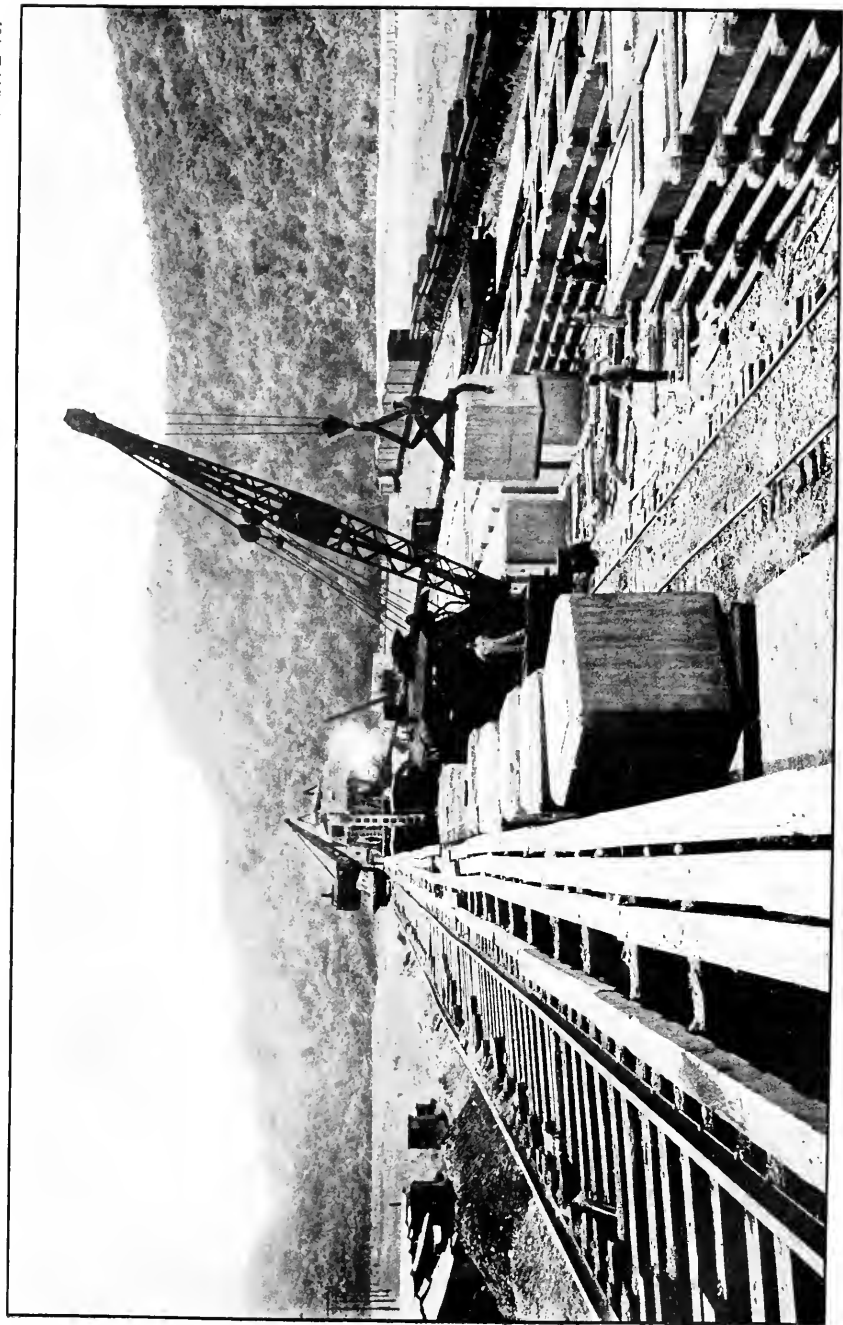
*Structural steel erection (general).*—The structural steel roof of the Ancon laundry building, including 142.4 tons of steel, was erected, 6,265 rivets being driven. The 55,000-barrel oil storage tank at La Boca was completed and accepted. In this work 61,324 rivets were driven. On the berm cranes the operating cable was strung, the coal hoppers, platforms, and runways completed, necessary alterations made, machinery inspected, greased, oiled, and put in working condition, and 50 per cent of the second coat of paint was applied. Repair work on shop buildings Nos. 5, 8, 19, 20, and 21, which were damaged by blasting in Sosa Hill, was 75 per cent completed. Scraping and painting steelwork in the pump well of the pump house and the interior work of building No. 29 were completed. Blacksmith work was done for the various subdivisions of the Pacific terminals. During the month 557.5 tons of steel were erected on the shed of Pier No. 7 at Cristobal, making a total of 2,090.5 tons erected, and 20,350 rivets driven.

#### GENERAL DESIGNING AND INSPECTION.

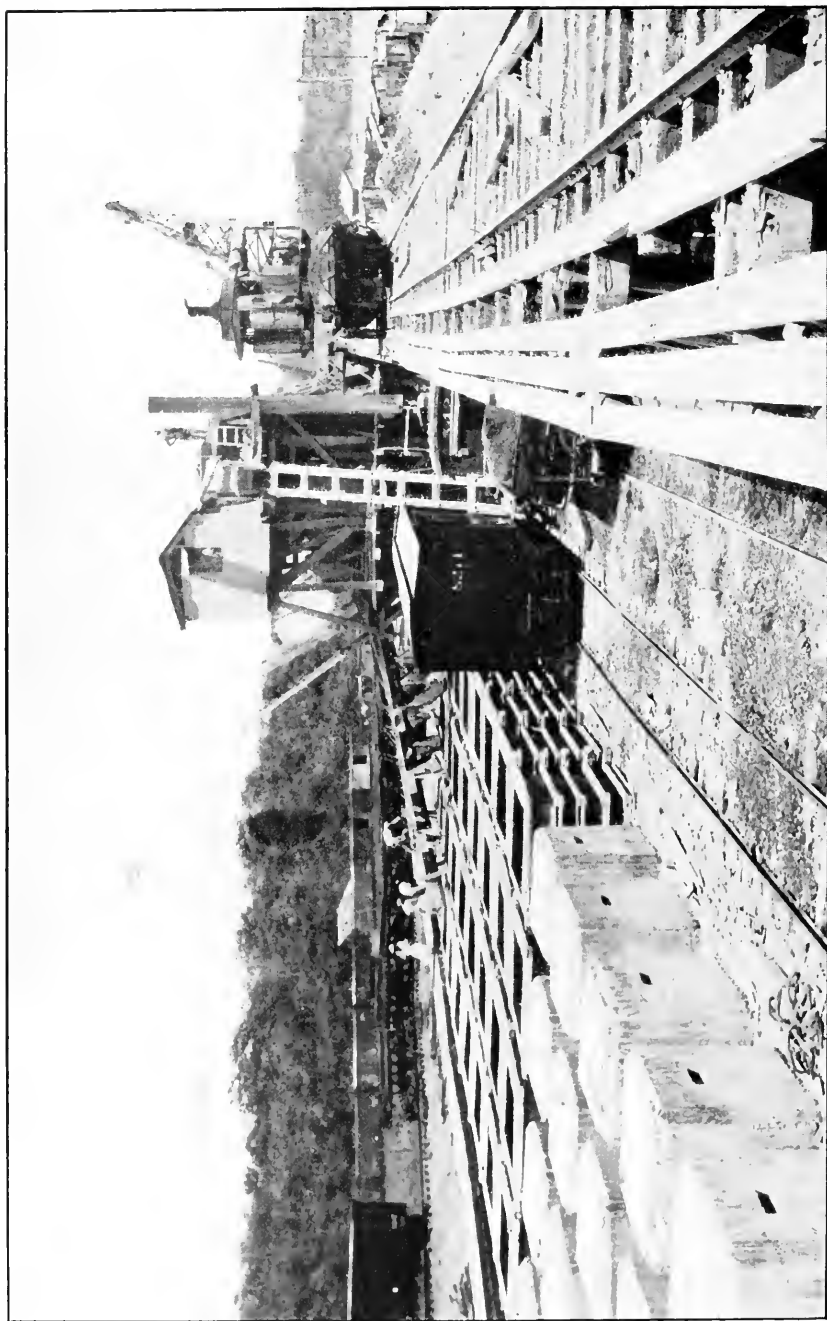
Working drawings were issued for various details of quay wall C-D-E and for the support and attachment of track work and specials. Work continued on the record drawings for the dry dock and entrance pier, and revision of existing drawings. Work was commenced on the construction drawings for that part of Dry Dock No. 2 which is still to be built, in accordance with the policy recently approved to prepare working drawings and specifications for the purchase of material before the present drafting force is finally disbanded. Construction drawings were completed and issued and work requests made on the building division for the construction of toilets to be suspended below the decks of the unloader, reloader, and end wharves of the Cristobal coaling plant. A drawing showing a suggested arrangement of toilets for the Balboa coaling plant employees was made and placed on file for future reference and consideration.

When the dredge *Corozal* was docked in the dry dock at Balboa opportunity was had to operate the main pumps of the dock for the first time. They operated smoothly under zero head. The main pumps were used to pump the dock down after the *Corozal* had entered the dock, and the pumps that were operated at this time worked smoothly. Observation was made of the behavior of the flooding valves and of hydraulic conditions generally, but no especial effort was made to observe and record more than general behavior and time required for flooding. Only one flooding valve was in action at this time.

CHESTER HARDING,  
*Engineer of Maintenance.*



GAMBOA CONCRETE BLOCK MANUFACTURING PLANT. LOOKING NORTH, SHOWING 40-TON CRANE HANDLING BLOCKS AND THE LARGE HOOK FOR SAME. GENERAL VIEW OF STORAGE PILE AND TRESTLE, WITH TRACKS SUPPORTING MIXING PLANT.



GAMBOA CONCRETE BLOCK MANUFACTURING PLANT. LOOKING SOUTH, SHOWING ENGINE USED FOR MOVING THE PLANT AND SUPPLYING STEAM TO ITS UNITS; ALSO THE ELEVATION OF CEMENT FROM THE CAR TO THE OPERATING PLATFORM.

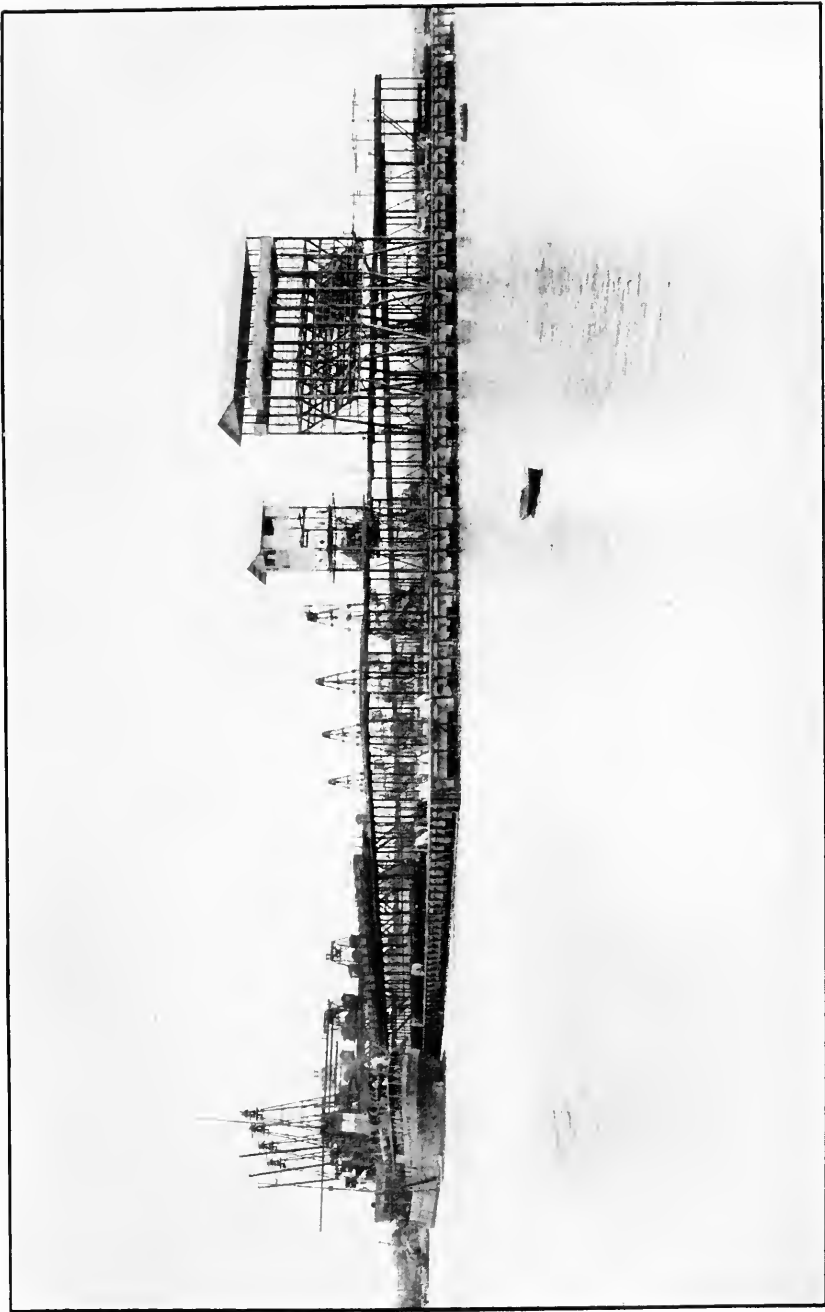


EAST BREAKWATER, LIMON BAY. PLOWING 25-TON CONCRETE BLOCKS FROM CARS TO FORM BREAKWATER. MARCH 13, 1916.

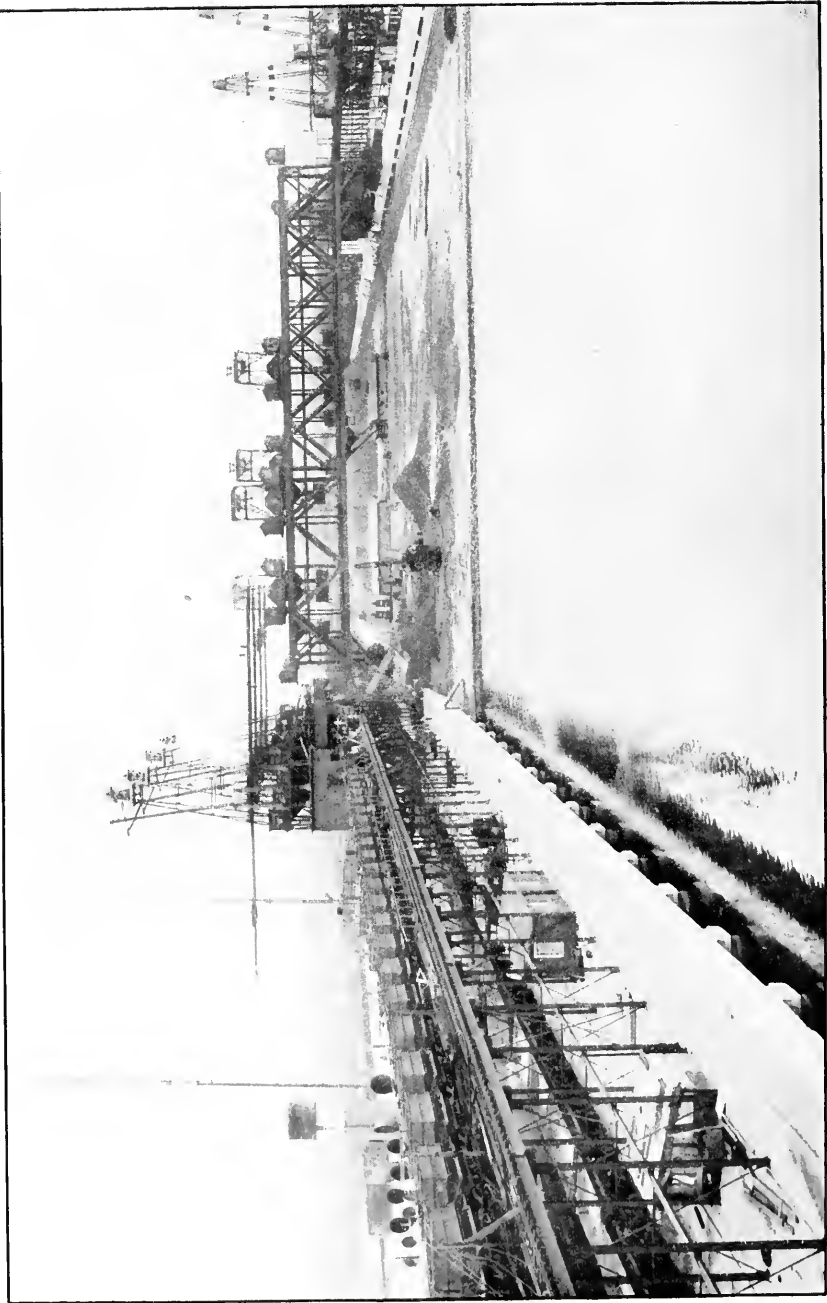


PIER NO. 7. REAR VIEW OF CONCRETE MIXING PLANT FOR CAISSONS. SEPTEMBER 2, 1915.

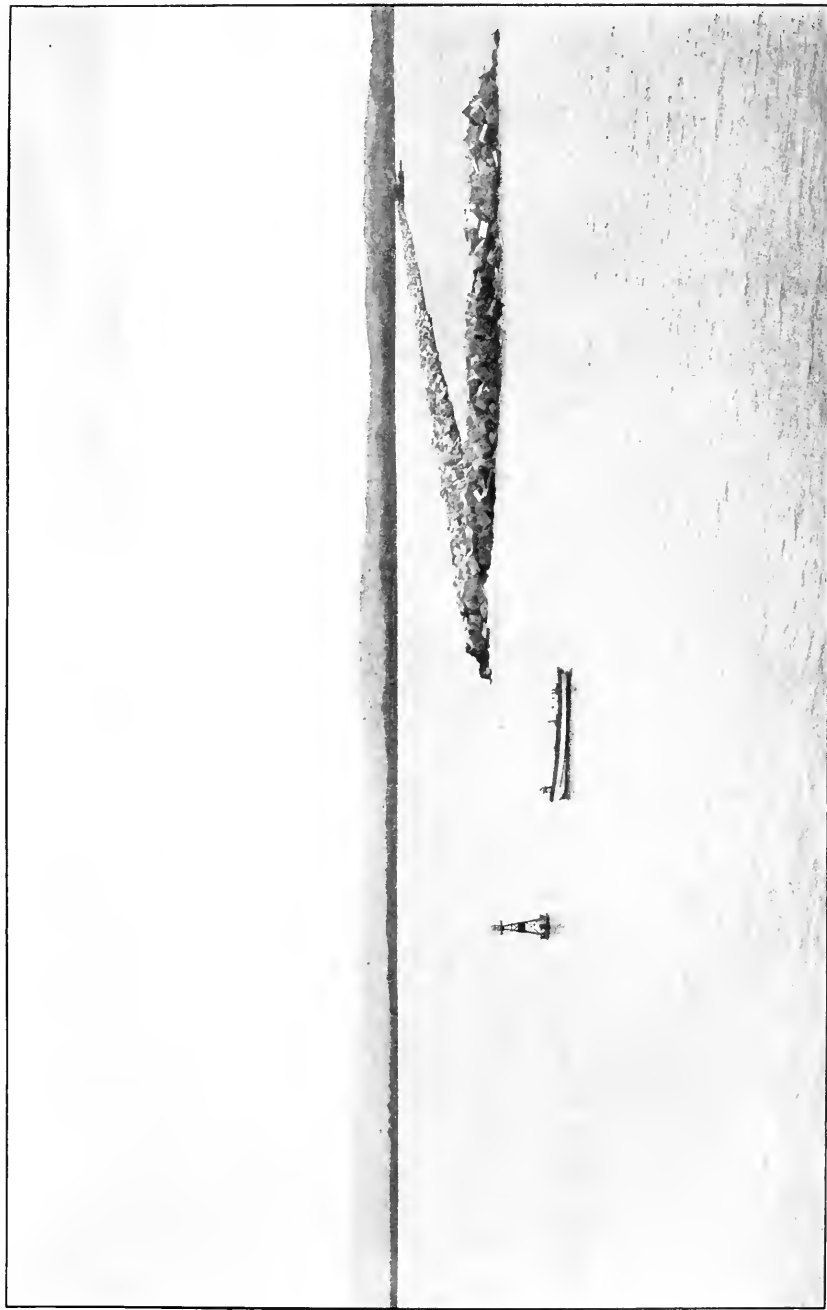




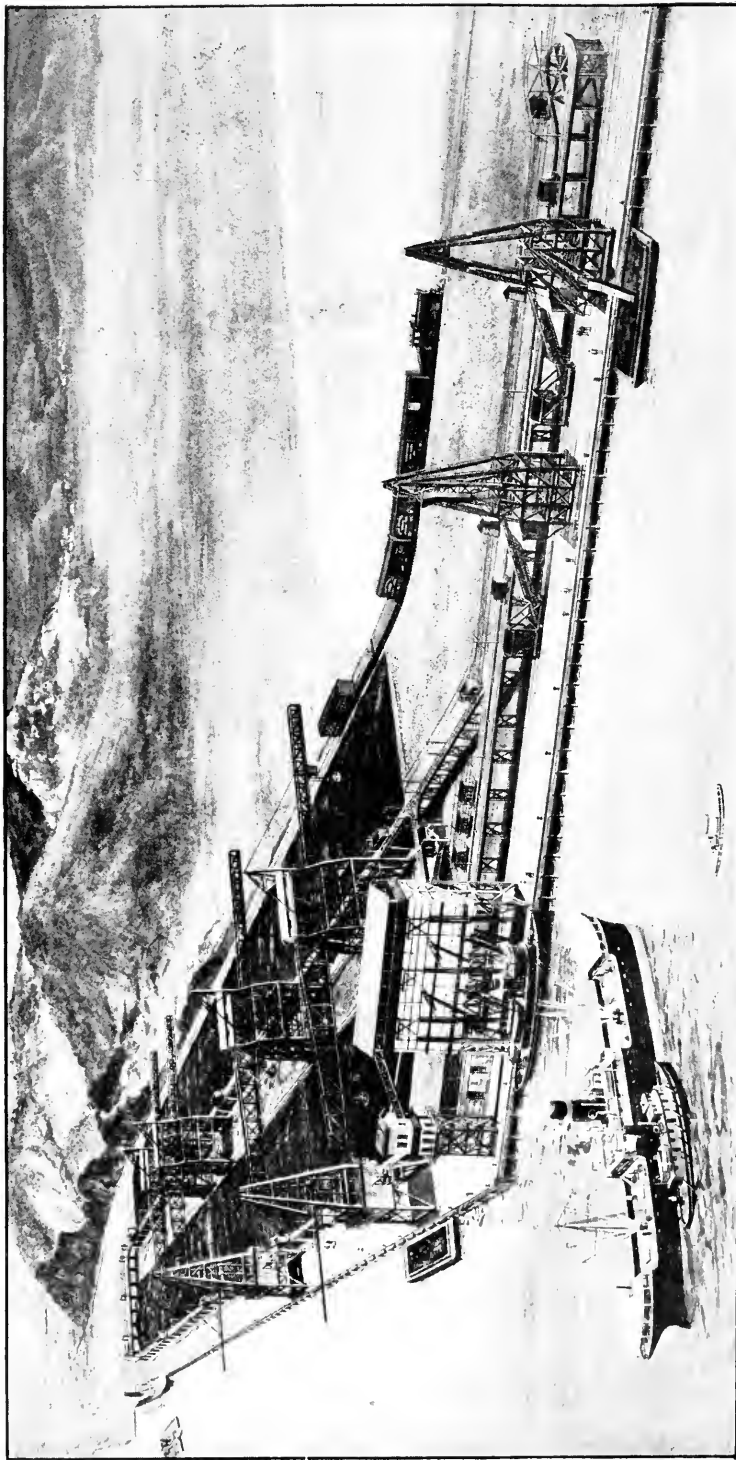
CRISTOBAL COALING STATION. LOOKING SOUTHWEST ON UNLOADER WHARF, SHOWING COLLIER "ULYSSES" AT WHARF FOR TESTS. FEBRUARY 28, 1916.



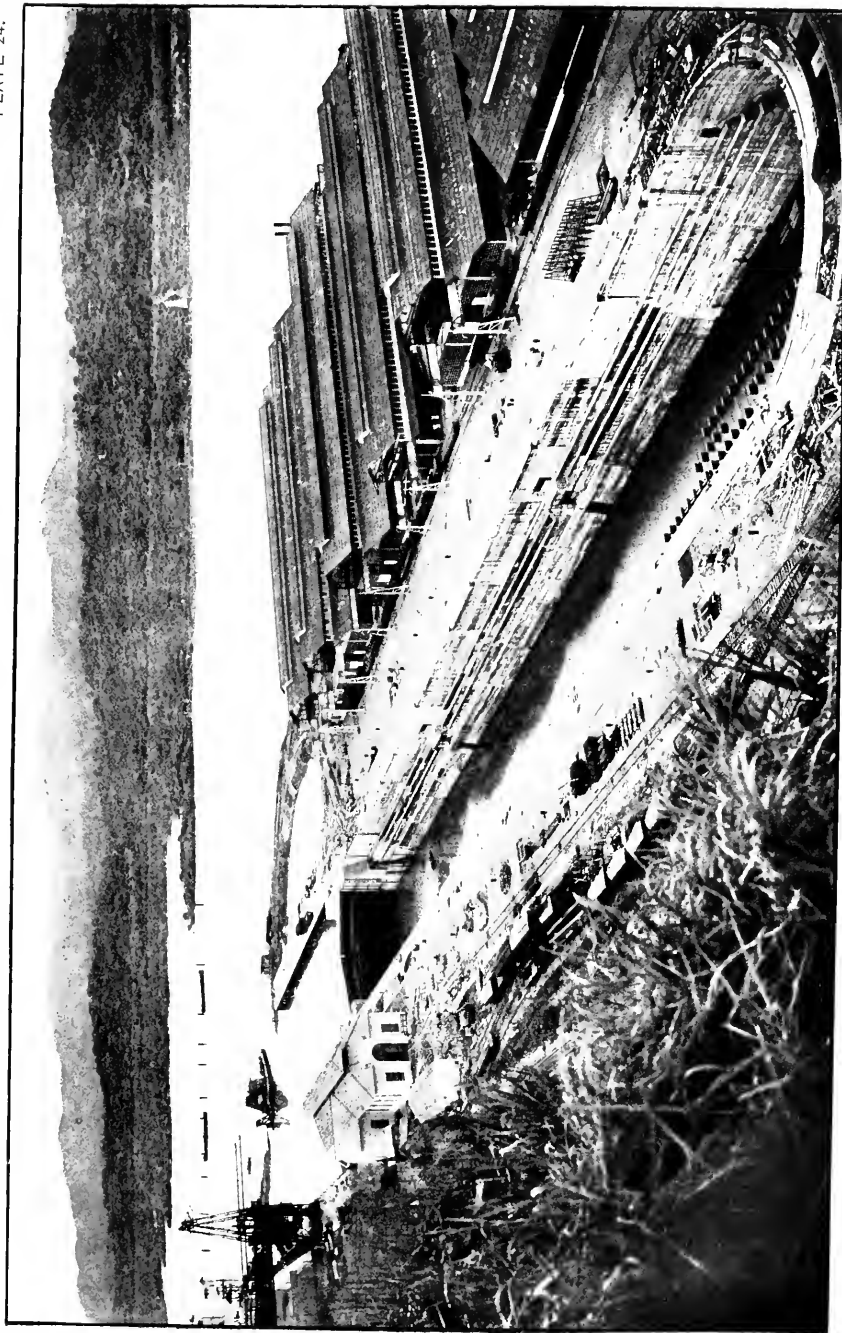
CRISTOBAL COALING STATION. LOOKING SOUTH FROM END WHARF VIADUCT. COLLIER "ULYSSES" AT DOCK. FEBRUARY 28, 1916.



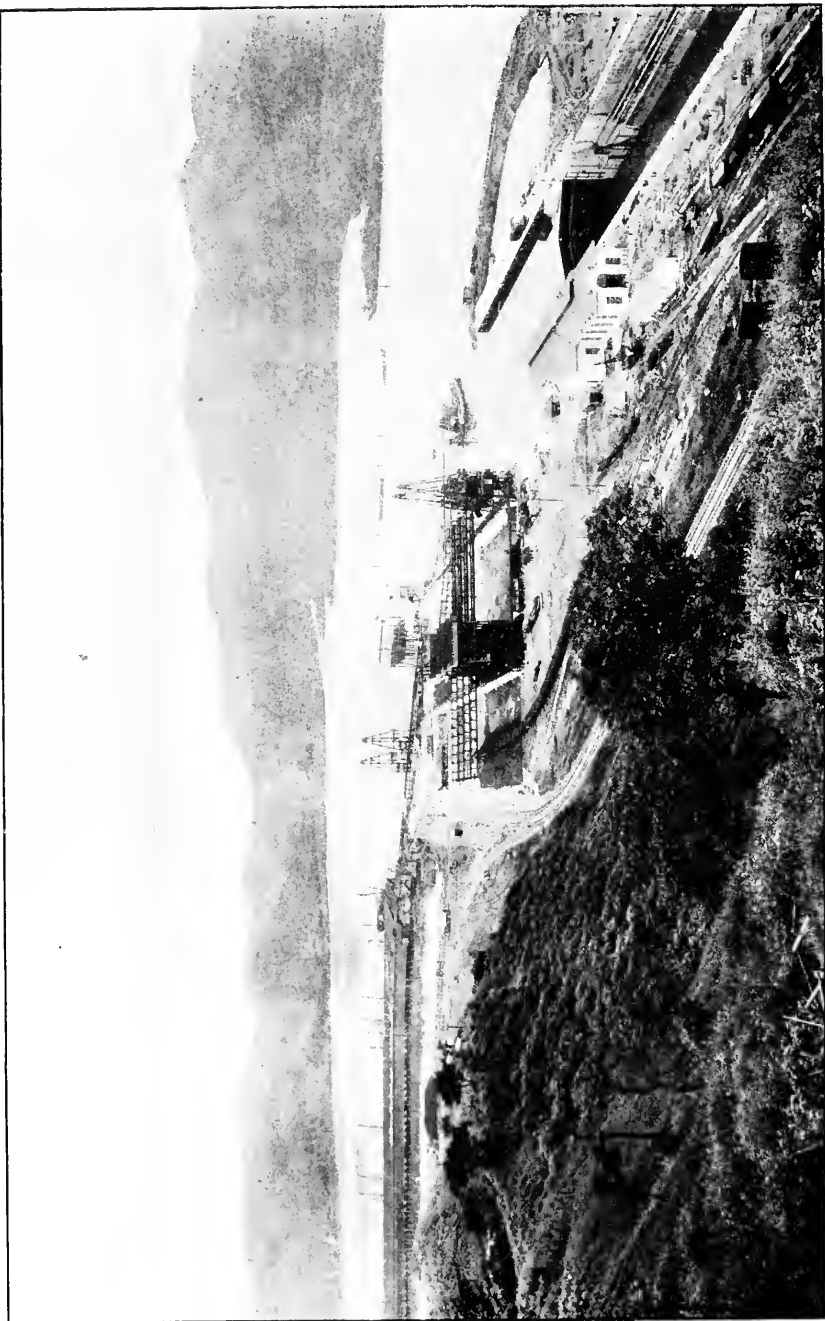
EAST BREAKWATER. ATLANTIC TERMINALS.



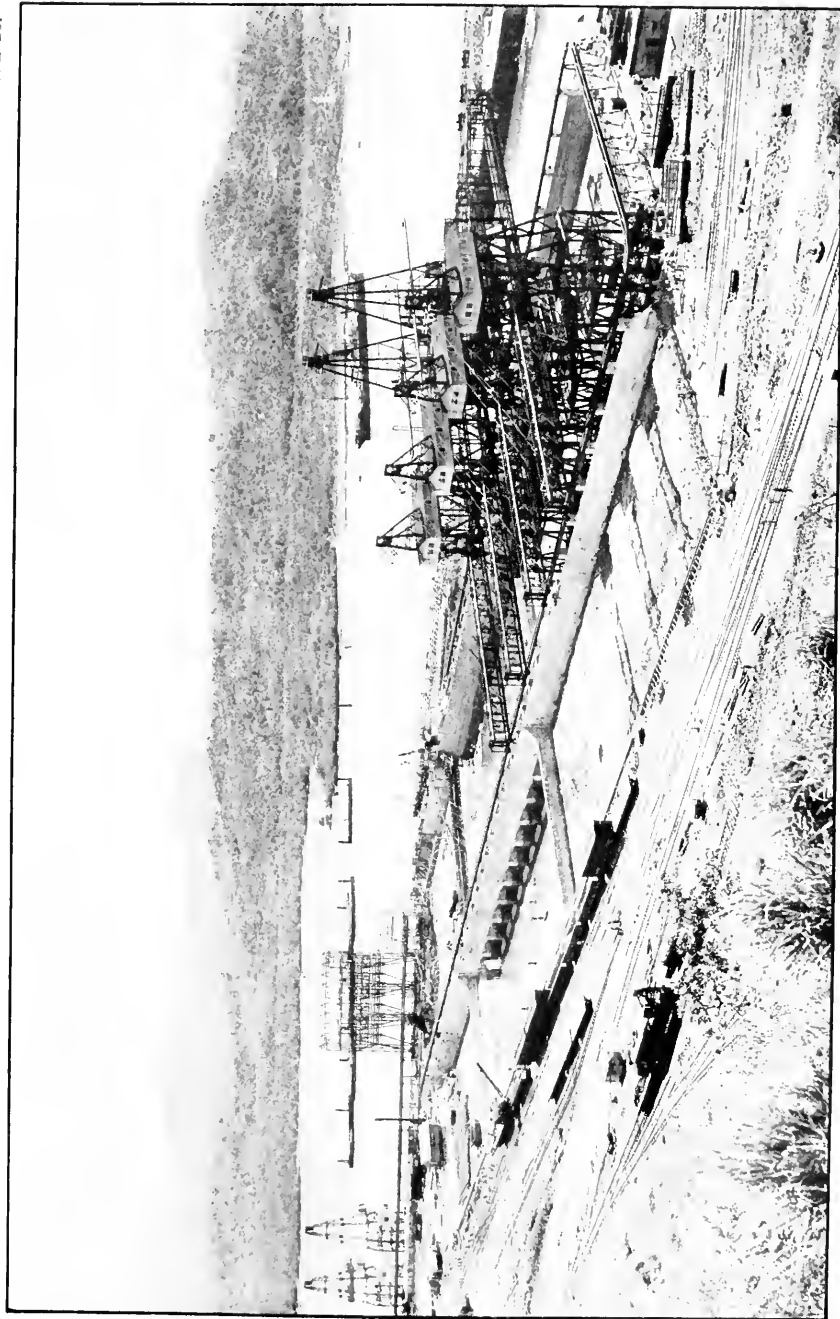
BALBOA TERMINALS. COALING PLANT FROM THE HARBOR. (COPY OF DRAWING.)



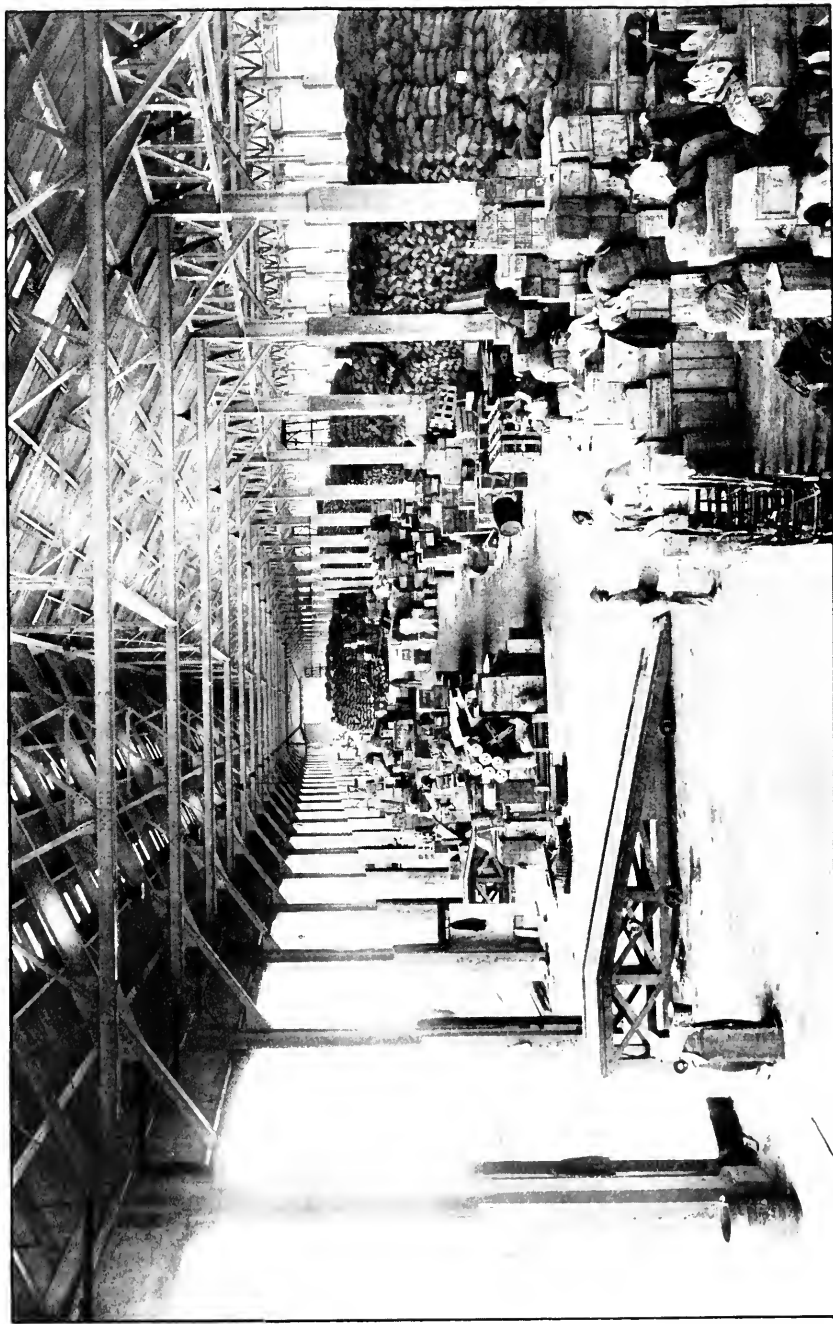
PACIFIC TERMINALS. GENERAL VIEW OF DRY DOCK NO. 1 FROM SOSA HILL, SHOWING MACHINE SHOPS AND ENTRANCE BASIN.  
JULY 5, 1916.



PACIFIC TERMINALS. COALING PLANT AND ENTRANCE BASIN TO DRY DOCK.

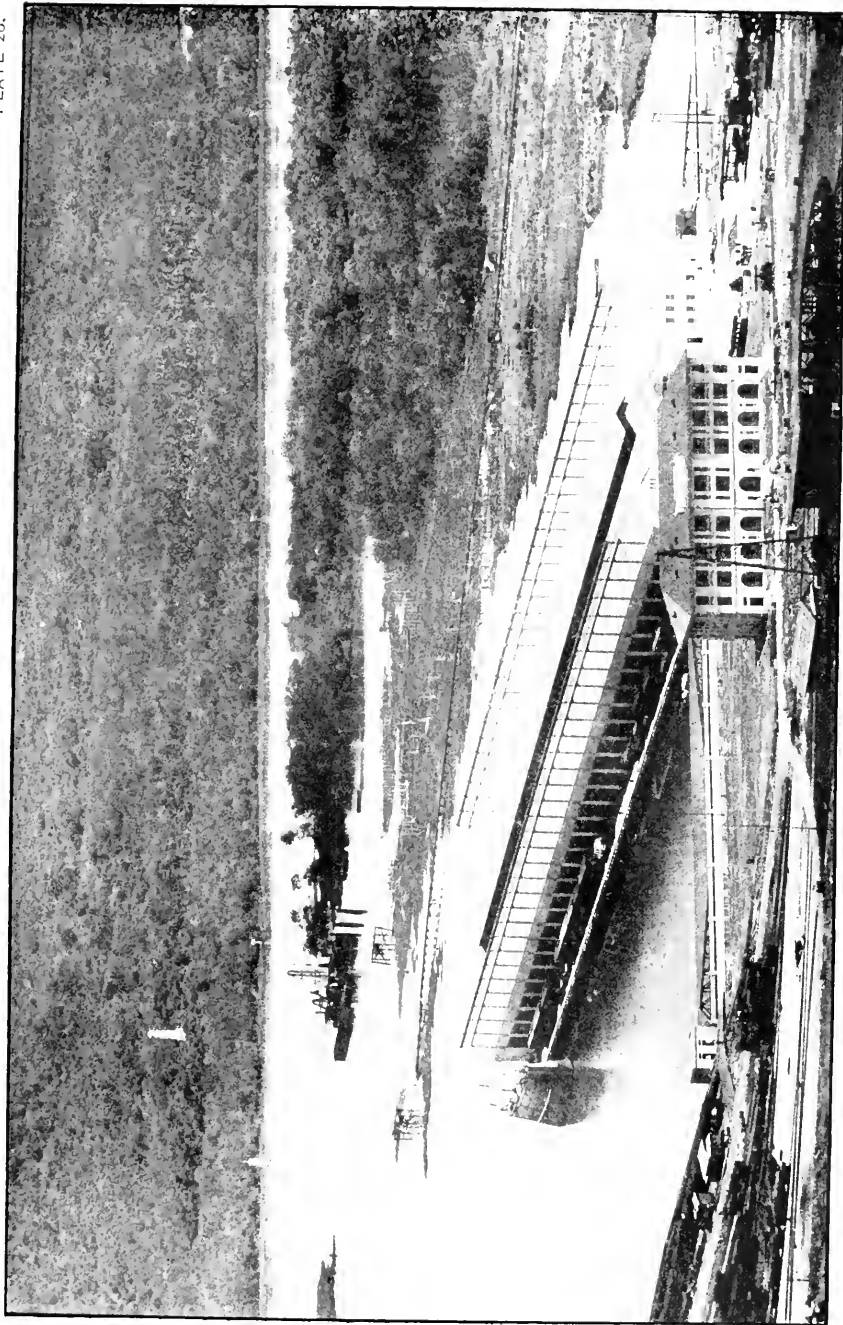


BALBOA TERMINALS. COALING STATION FROM SOSA HILL. APRIL 25, 1916.

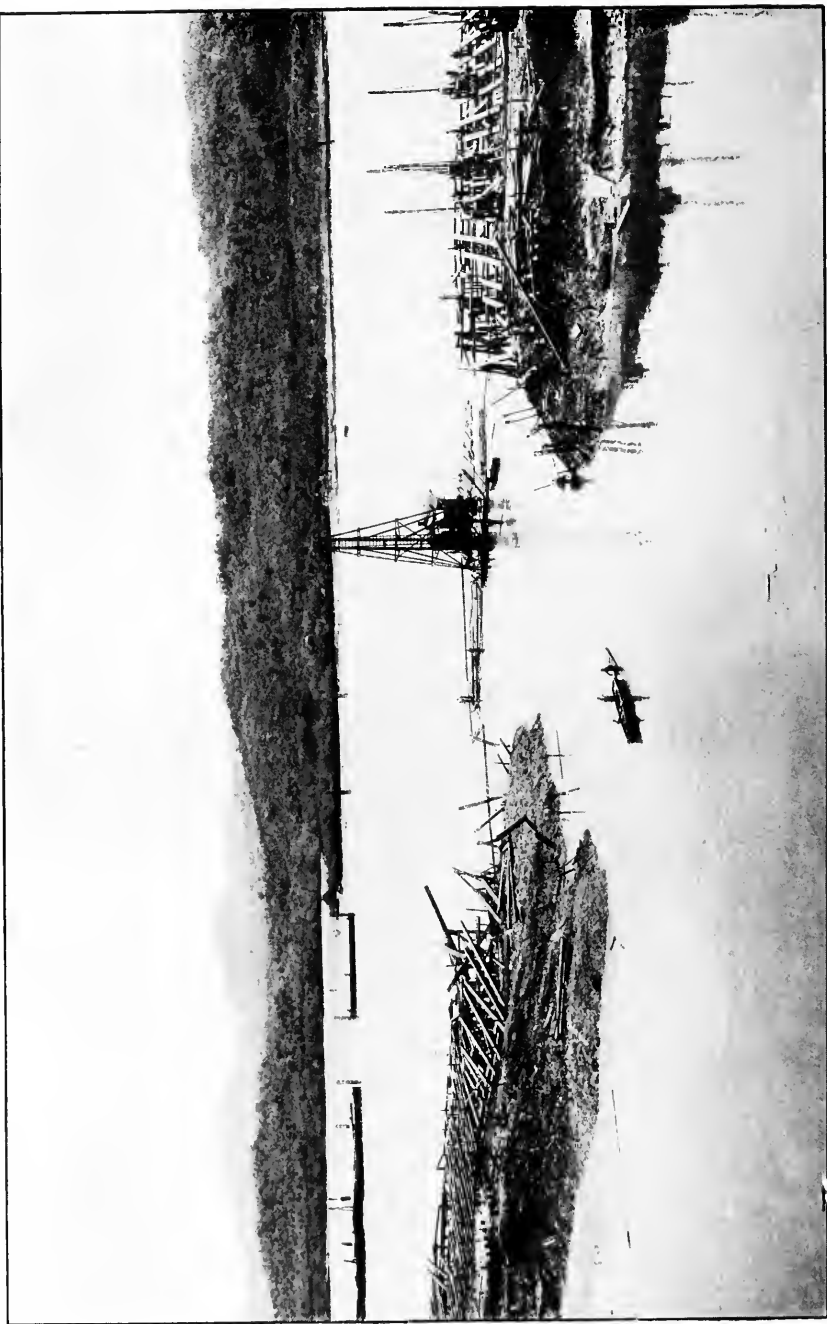


BALBOA TERMINALS. INTERIOR OF PIER NO. 18. APRIL 20, 1916.

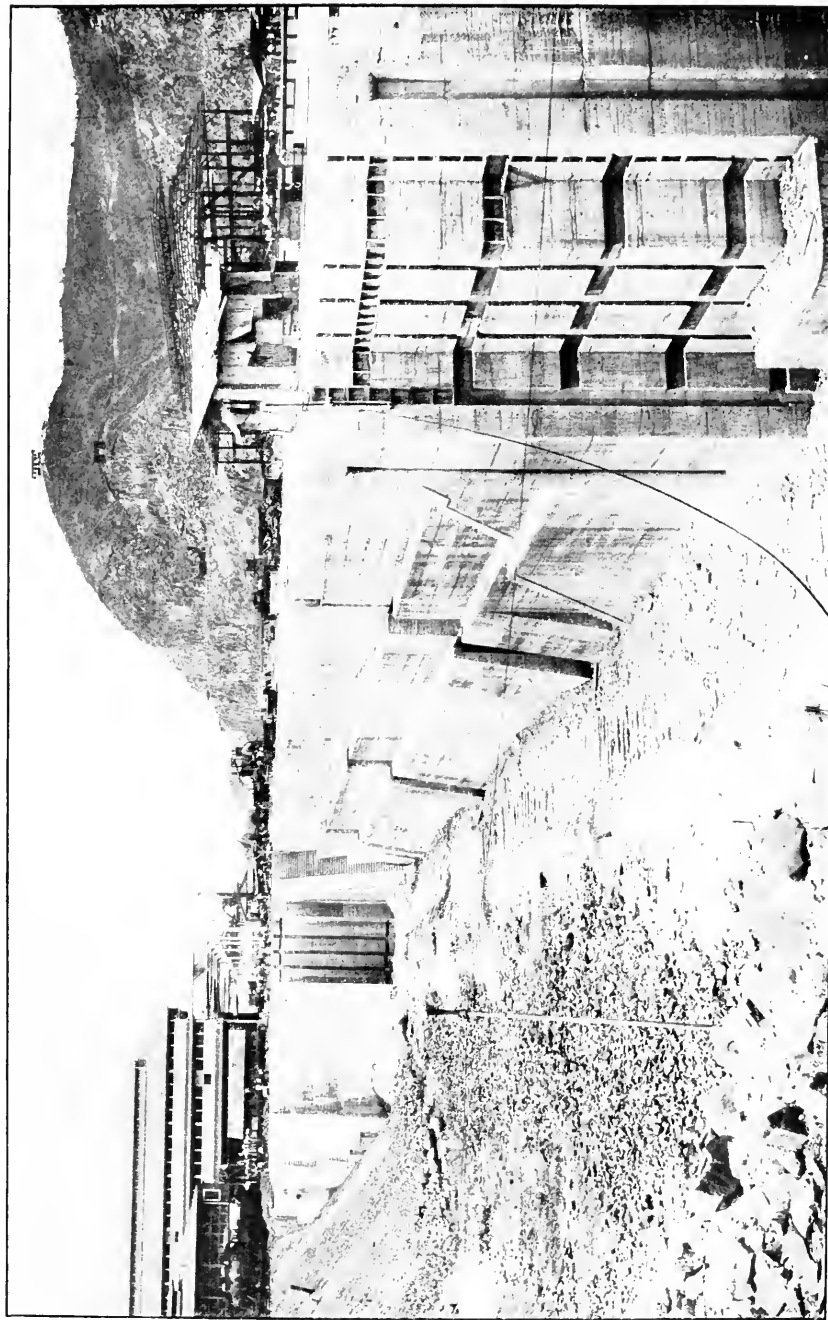




PACIFIC TERMINALS. PIER NO. 18, PACIFIC TERMINAL OFFICE BUILDING AND PORTION OF INNER HARBOR.



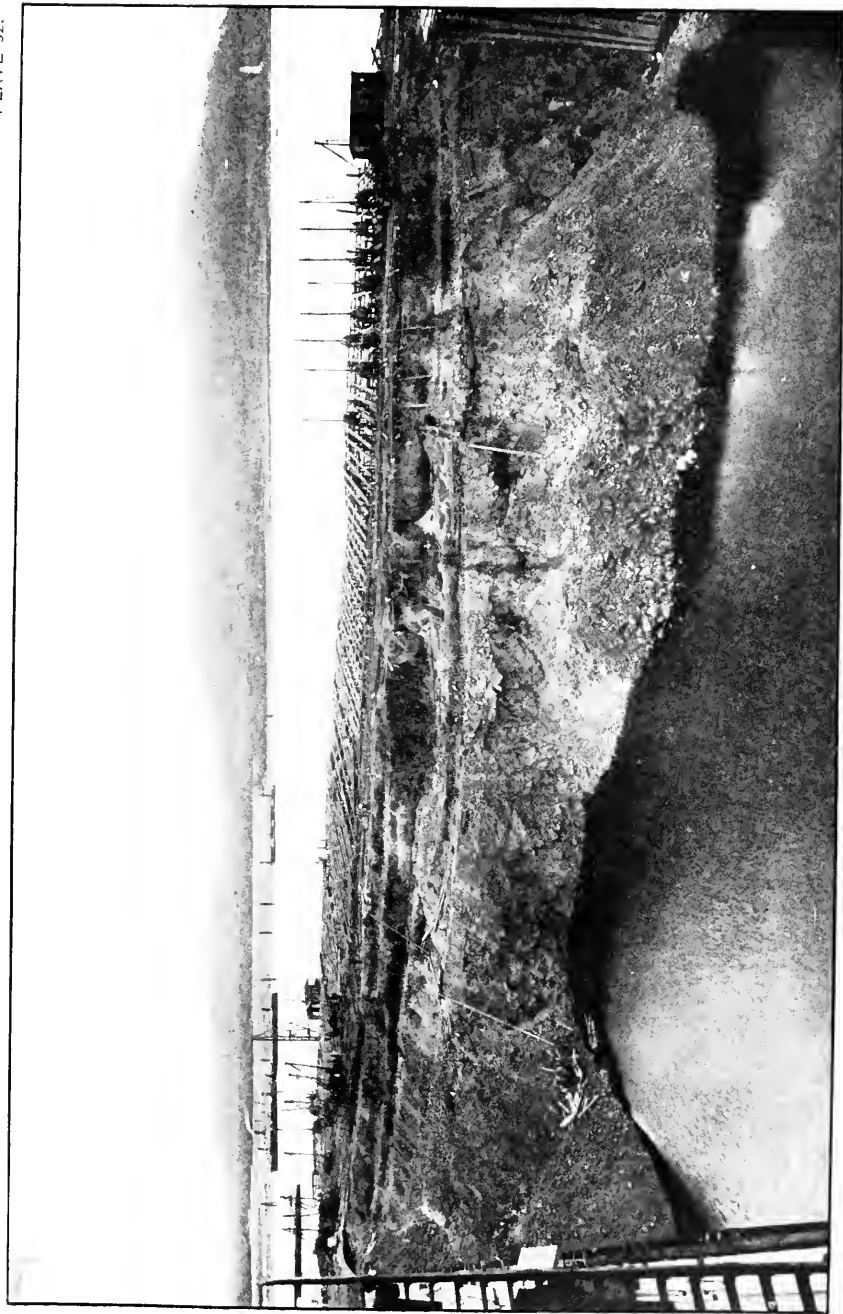
BALBOA TERMINALS. PROTECTION DIKE FOR DRY DOCK NO. 1 AFTER BLAST. LOW TIDE. APRIL 25, 1916.



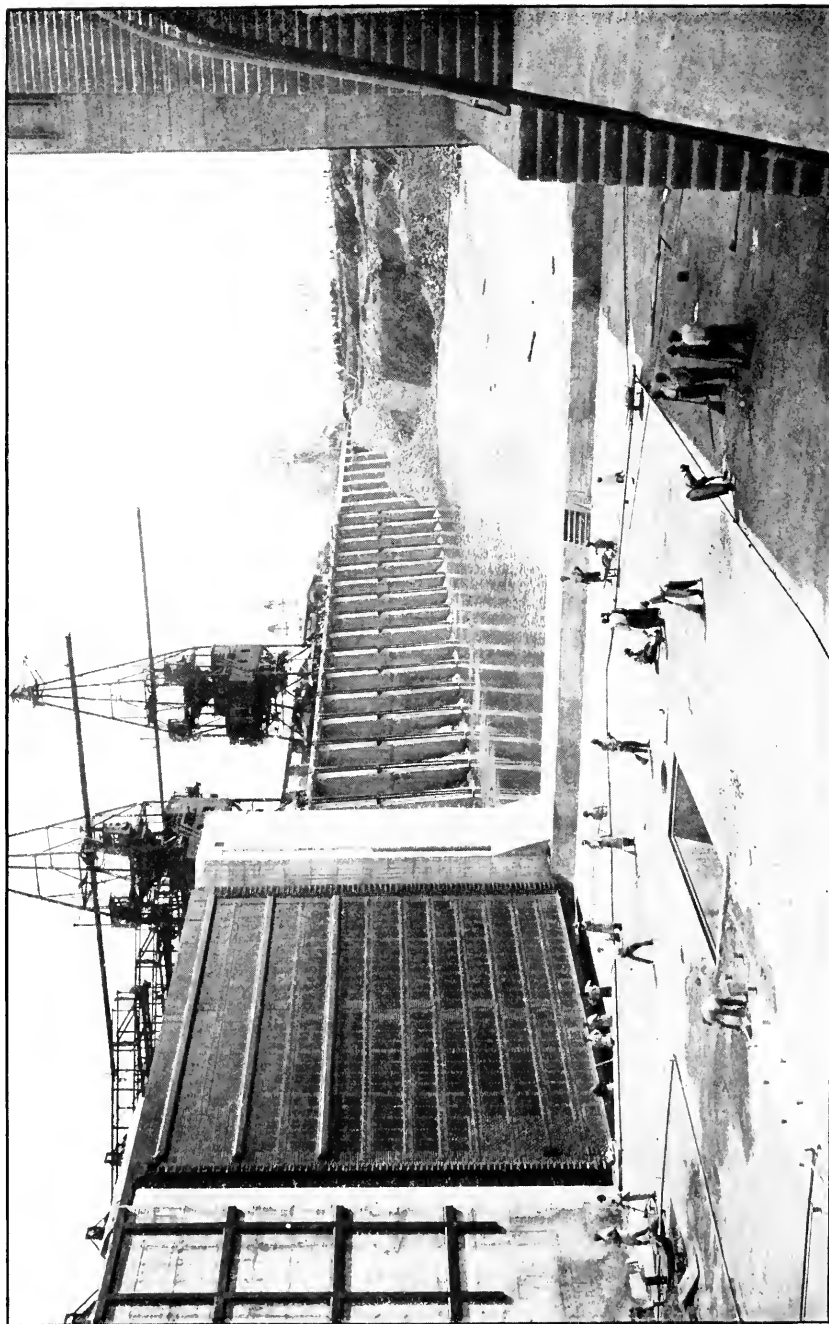
BALBOA TERMINALS. DRY DOCK NO. 2 BEFORE FLOODING. APRIL 19, 1916.



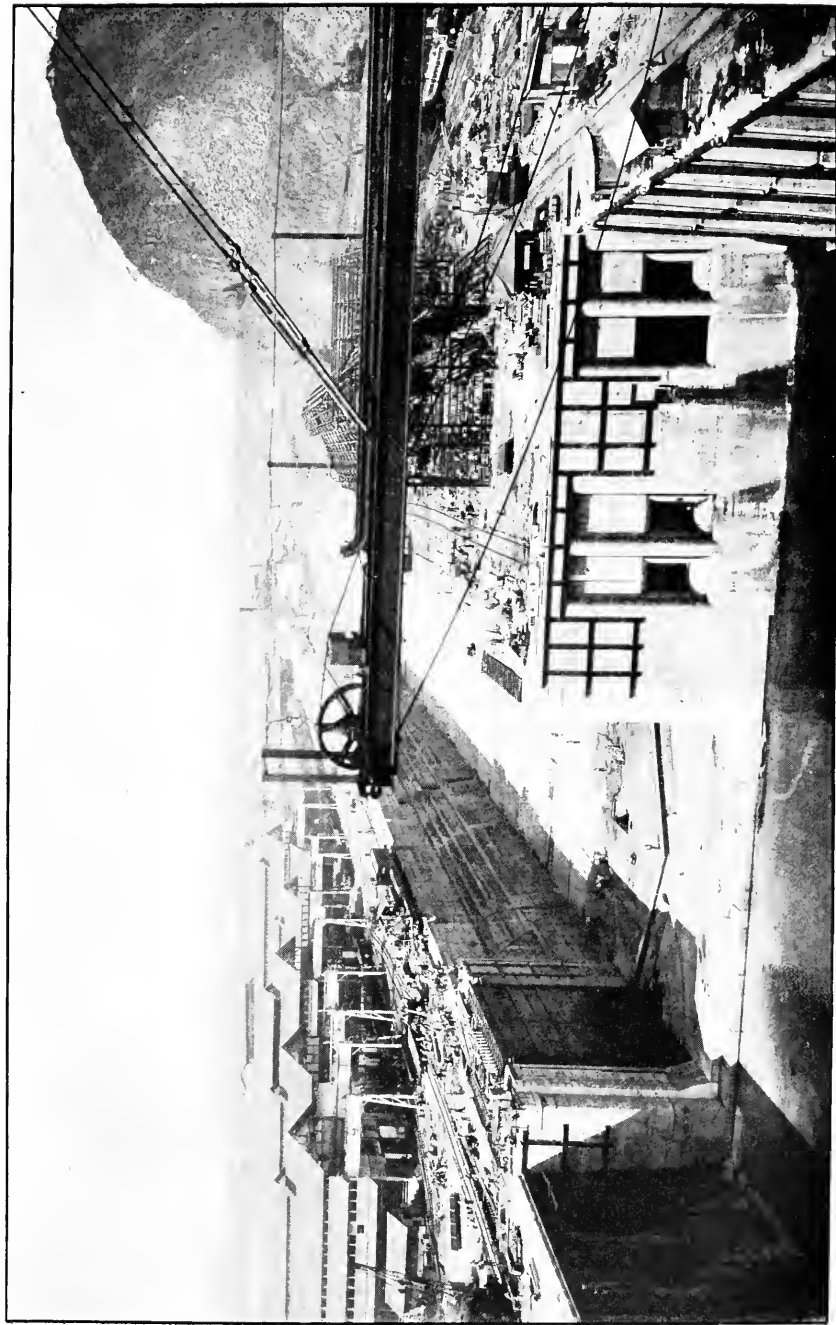
BALBOA TERMINALS, ENTRANCE BASIN TO DRY DOCK NO. 1, BLOWING UP PROTECTION DIKE, APRIL 23, 1916.



BALBOA TERMINALS. PROTECTION DIKE FOR DRY DOCK NO. 1, FROM UNLOADER TOWER. APRIL 10, 1916.

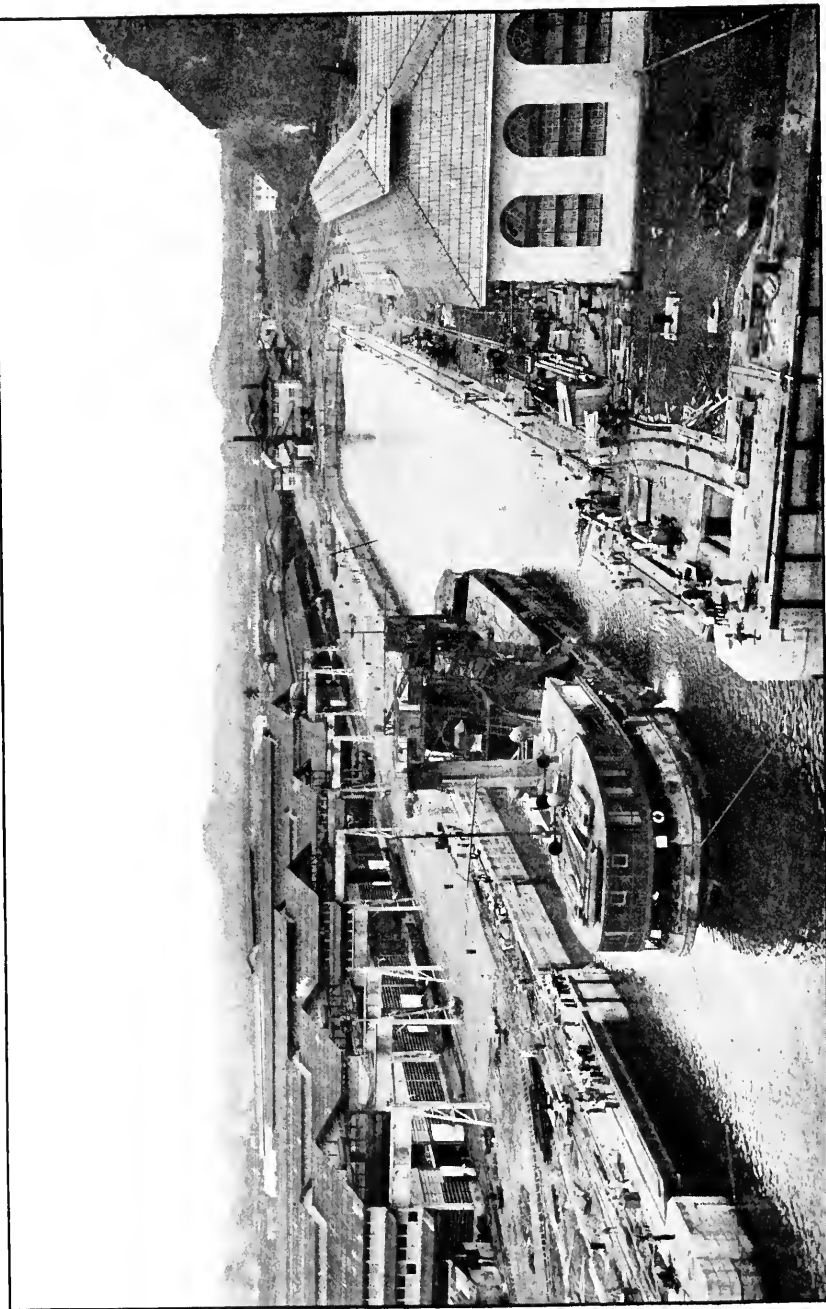


BALBOA TERMINALS. DRY DOCK NO. 1, ENTRANCE BASIN READY TO BE FLOODED. APRIL 3, 1916.



BALBOA TERMINALS. DRY DOCK NO. 1 BEFORE FLOODING. LOOKING EAST. APRIL 3, 1916.





PACIFIC TERMINALS. U. S. DREDGE "COROZAL" ENTERING DRY DOCK, BALBOA, CANAL ZONE. JUNE 27, 1916.



## APPENDIX D.

### REPORT OF THE RESIDENT ENGINEER, BUILDING DIVISION.

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BALBOA HEIGHTS, CANAL ZONE, *July 31, 1916.*

SIR: I have the honor to submit the following report covering the operation of the building division during the fiscal year ending June 30, 1916.

#### ORGANIZATION.

At the close of the last fiscal year the work of the division was being carried on in five districts or subdivisions, viz, Northern District, Central District, Southern District, Fort Amador District, and designs. September 1 the Fort Amador District was consolidated with the Southern District, and placed in charge of Superintendent J. B. Fields. The Northern District continued in charge of Superintendent James Cosgrove, and the Central District in charge of Superintendent E. L. Galliher. Architect Samuel M. Hitt remained in charge of the architectural branch of the designing sub-division, and Assistant Engineer T. C. Morris remained in charge of the engineering designs.

#### BUILDING OPERATIONS.

##### BUILDINGS AUTHORIZED AND CONSTRUCTED.

The work carried on by the division is divided into three general classes, viz, construction of all new buildings for the canal and the Panama Railroad; maintenance and repair of existing canal and Panama Railroad buildings, where such repairs exceed \$50 in cost for any one item; and construction of buildings for the Coast Artillery and mobile troops. Under the classification "New Buildings for the Canal" are included all buildings for which definite congressional appropriations are made; buildings specially authorized for construction by the Governor; and buildings authorized for construction by the Panama Railroad. Under the classification "Army work" are included all buildings listed in the two appropriations known as the \$700,000 and \$1,290,000 appropriations, and also such additional new buildings as were authorized from time to time by special orders of the Secretary of War. The buildings authorized under the \$700,000 appropriation having been practically completed by the close of the fiscal year 1915, work during the past year was confined to buildings carried in the \$1,290,000 appropriation.

The following tables give all principal buildings costing more than \$1,000 that were in course of construction at the beginning of the fiscal year, and all buildings authorized during the year on which construction was commenced and completed or partially completed.

## CANAL AND PANAMA RAILROAD BUILDINGS.

Item.	Name of building.	Number of buildings.	Type.	Date completed.	Cost.
<i>Under construction July 1, 1915.</i>					
1	1-family cottage.....	10	Type 17, revised frame..	July, 1915.....	\$21,324.11
2	4-family quarters.....	16	Type 14, revised frame..	August, 1915.....	82,680.80
3	2-family quarters.....	7	Type 4, revised frame.....	do.....	34,529.14
4	4-family quarters.....	10	Concrete, new type.....	September, 1915.....	211,701.61
5	2-family quarters.....	2	do.....	August, 1915.....	30,588.33
6	Corozal Railroad station.....	1	Concrete.....	July, 1915.....	17,173.88
7	Hospital, Colon.....	4	do.....	March, 1916.....	172,169.70
8	Slaughterhouse.....	1	Concrete and frame.....	September, 1915.....	4,640.79
9	Extension of Miraflores power house.....	1	Concrete.....	August, 1915.....	35,129.77
10	P. R. R. stables, Panama.....	8	Concrete and frame.....	October, 1915.....	38,907.82
	Total.....	60			648,845.95
<i>Buildings commenced during year.</i>					
11	Crematory.....	1	Concrete.....	November, 1915.....	13,126.24
12	Bachelor Pilots' Building.....	1	Frame.....	do.....	5,698.14
13	Refrigerating and ice plant, exclusive of machinery.....	1	Concrete.....	May, 1916.....	130,683.79
14	Garage, 10 stalls.....	1	Concrete and frame.....	November, 1915.....	3,059.47
15	Colored married quarters.....	7	Frame, 12 families each.....	do.....	34,370.04
16	Stock pens.....	1	Frame.....	do.....	2,750.76
17	Office and apartment building, American Bible Society.....	1	Concrete, terra-cotta.....	95 per cent.....	
18	New Ancon Hospital.....	4	do.....	May, 1916.....	129,182.50
19	Reconstruction of old Ancon administration building.....	1	Concrete.....	January, 1916.....	27,960.85
20	1-family cottage.....	1	Type 17, revised frame.....	November, 1915.....	2,129.56
21	Ice-cream and milk-bottling plant.....	1	Concrete, terra-cotta.....	85 per cent.....	
22	Quarters for cripples, Corozal.....	1	Frame.....	November, 1915.....	3,059.94
23	4-stall garage, Cristobal.....	1	do.....	December, 1915.....	817.18
24	Bachelor building, colored employees.....	1	do.....	do.....	5,222.62
25	6-stall garage.....	1	Frame and concrete.....	do.....	1,406.05
26	Cattle-dipping tank.....	1	Concrete.....	November, 1915.....	1,049.43
27	Terminal building, Balboa.....	1	Concrete and terra-cotta.....	June, 1916.....	70,594.76
28	Bachelor building, Ancon.....	1	do.....	do.....	69,139.25
29	Laundry.....	1	Concrete and steel.....	do.....	68,849.69
30	Y. M. C. A. clubhouse, Ancon.....	1	Frame.....	March, 1916.....	19,877.84
31	10-stall garage.....	1	Frame and concrete.....	December, 1915.....	1,979.89
32	Yacht Club, Balboa.....	1	Frame.....	May, 1916.....	9,715.26
33	6-stall garage.....	2	Frame and concrete.....	January, 1916.....	4,659.66
34	Launch—superintendent's building, Balboa.....	2	Concrete.....	February, 1916.....	1,656.48
35	Office building, Cristobal coal-ing plant.....	1	Concrete and steel.....	June, 1916.....	20,895.06
36	(10-stall) (20-stall) garages.....	2	Frame and concrete.....	March, 1916.....	5,989.11
37	Swimming pool, Balboa.....	1	Concrete.....	May, 1916.....	11,391.12
38	Dressing room, bathhouse.....	1	Concrete and frame.....	do.....	3,415.92
39	Tower water tank.....	1	Concrete.....	March, 1916.....	7,456.26
40	Poultry building.....	1	Frame.....	April, 1916.....	2,612.70
41	Toilet building No. 25, Balboa terminals.....	1	Concrete and steel.....	May, 1916.....	7,050.89
42	Panama R. R. stable extension, Panama City.....	8	Concrete and frame.....	June, 1916.....	31,372.70
43	Signal station.....	1	Type 17, frame cottage.....	April, 1916.....	5,214.56
44	Electric repair shop, Gatun.....	1	Concrete and frame.....	May, 1916.....	1,911.50
45	Hotel building, Gatun.....	1	do.....	75 per cent.....	
46	Terminal building, Cristobal.....	1	Concrete and terra cotta.....	30 per cent.....	
47	Storehouse, dredge parts, Paraiso.....	1	Frame.....	May, 1916.....	3,252.58
48	Commissary building, Margarita.....	1	do.....	do.....	62.00
49	Air compressor and pump building No. 29, Balboa terminals.....	1	Concrete and steel.....	June, 1916.....	38,461.71
50	Store building, Colon Hospital.....	1	Concrete and terra cotta.....	do.....	4,447.96
51	Coal bunker, Balboa.....	1	Concrete.....	do.....	10,830.37
52	Mess building, locks.....	2	Concrete and frame.....	do.....	7,484.49
53	Bathhouse, Washington Hotel.....	1	Concrete and terra cotta.....	60 per cent.....	
54	Local freight and baggage building, Panama R. R., Cristobal.....	1	Concrete and steel.....	20 per cent.....	
55	Toilet rooms, Cristobal coal-ing station.....	1	Concrete.....	75 per cent.....	
56	Pattern storage building.....	1	Concrete and frame.....	55 per cent.....	

1 Set.

## CANAL AND PANAMA RAILROAD BUILDINGS—Continued.

Item.	Name of building.	Number of buildings.	Type.	Date completed.	Cost.
	<i>Buildings commenced during year—Continued.</i>				
57	Motor-bus repair shop.....	1	.....do.....	5 per cent.....	.....
58	Bowling alleys, La Boca Y. M. C. A. clubhouse.....	1	Concrete.....	1 per cent.....	.....
	Total.....	68	.....	.....	\$768,021.15

Total number canal and Panama R. R. buildings completed or partially completed during year, 128.  
Total cost of completed buildings, \$1,416,867.10.

## ARMY BUILDINGS.

Item.	Name of building.	Number of buildings.	Type.	Date completed.	Cost.
	<i>Under construction July 1, 1915.</i>				
59	Field office quarters.....	2	Concrete and terra cotta.	September, 1915.	\$27,845.90
60	4-family lieutenant's quarters.....	2	.....do.....	.....do.....	40,764.55
61	2-family captains' quarters.....	3	.....do.....	.....do.....	44,415.73
62	Noncommissioned officers' quarters.....	3	.....do.....	August, 1915.....	36,608.40
63	Barracks.....	4	Concrete and frame floors.	September, 1915.	131,517.39
64	Engineer company stables.....	1	Concrete and frame.....	July, 1915.....	5,932.31
65	Wagon shed, Engineer company.....	1	Frame.....	.....do.....	1,473.62
66	Signal company stables.....	3	Concrete and frame.....	.....do.....	7,871.94
67	Signal company wagon shed.....	1	Frame.....	.....do.....	1,406.41
68	Stables, ambulance company.....	3	Concrete and frame.....	.....do.....	8,417.30
69	Wagon sheds, ambulance company.....	1	Frame.....	.....do.....	2,023.09
70	Stables, Cavalry.....	3	Concrete and frame.....	November, 1915.	40,313.29
71	Equipment buildings, Cavalry.....	3	Frame.....	.....do.....	12,240.07
72	Stable, Artillery.....	4	Concrete and frame.....	December, 1915.....	47,653.24
73	Equipment buildings.....	4	Frame.....	September, 1915.....	9,351.49
74	Double mess building.....	1	.....do.....	August, 1915.....	3,146.59
75	1-family cottage.....	3	Type 17, old cls., frame..	July, 1915.....	5,054.29
76	200,000-gallon water tank.....	1	Concrete.....	August, 1915.....	5,096.10
	Total.....	43	.....	.....	431,131.71
	<i>Buildings commenced during year.</i>				
77	Pump station and sump.....	1	Concrete.....	November, 1915.	5,760.81
78	Lieutenants' quarters.....	6	Type E/2, 1-family frame	December, 1915.	27,830.41
79	Captains' quarters.....	3	Type 20, 1-family frame.	January, 1916.....	18,134.51
80	Storehouse, Amador.....	1	Concrete, terra cotta.....	October, 1915.....	26,715.60
81	Storehouse, Naos.....	1	.....do.....	January, 1916.....	21,844.30
82	Staff quarters.....	5	Type 8, frame, slate roofs.	November, 1915.	39,945.19
83	.....do.....	1	Type 21, frame.....	.....do.....	6,058.26
84	.....do.....	1	Type 20, frame.....	October, 1915.....	7,073.49
85	Lieutenants' quarters.....	2	Type E/2, frame.....	December, 1915.....	8,506.49
86	Commanding officer's quarters.....	1	Type 3, frame.....	February, 1916.....	7,570.87
87	Headquarters building.....	1	Frame.....	March, 1916.....	30,800.70
88	Barracks, Quartermaster company.....	2	.....do.....	.....do.....	49,900.45
89	Noncommissioned officers'.....	2	Type 14, revised frame..	February, 1916.....	15,653.89
90	Stable and wagon shed.....	2	Concrete and frame.....	November, 1915.....	5,184.06
91	Storehouse.....	1	Concrete.....	March, 1916.....	31,674.31
92	Staff quarters.....	2	Type 20, frame.....	January, 1916.....	14,616.89
93	.....do.....	1	Type 21, frame.....	.....do.....	5,759.75
94	Quarters, colored employees, Navy, Darien.....	1	Frame.....	November, 1915.	2,279.86
95	Dock, Margarita.....	1	Timber.....	May, 1916.....	14,616.76
96	Storehouse.....	1	Concrete and frame.....	.....do.....	17,911.45
97	Incinerator.....	1	Concrete and brick.....	June, 1916.....	7,644.62
98	Barracks, Artillery.....	1	Frame.....	March, 1916.....	10,505.31
99	Storehouse, Engineers.....	1	Concrete.....	May, 1916.....	4,838.63
100	Stable and wagon shed.....	2	Concrete and frame.....	April, 1916.....	3,405.62
101	Storehouse, signal.....	1	.....do.....	.....do.....	1,355.40
102	Storehouse, ordnance.....	1	Frame.....	.....do.....	6,045.91
	Total.....	43	.....	.....	391,633.54

Total number Army buildings completed or partially completed during year, 86.

Total cost of completed buildings, \$822,765.25.

Total number of buildings completed or partially completed for the canal, Panama Railroad, and Army, 214; total cost completed buildings, \$2,239,632.35.

In addition to the above work there were constructed a large number of smaller buildings, costing between \$200 and \$1,000. The total number of separate pieces of work costing in excess of \$50, for which authority for expenditure was issued, amounted to 823. The total number of small jobs accomplished, costing less than \$50, amounted to 237.

Among the principal items of special work handled by the division during the year may be mentioned the following: Installation of refrigeration and ice manufacturing equipment in the new Balboa refrigerating plant; the design and installation of time ball and signal apparatus for the Sosa Hill signal station; the relining with cast iron the baffle piers, in the Gatun Spillway; installation of vault, marble counters, and grill work in the Commercial Bank, Panama City; installation new metal trim and hardware and refinishing exterior walls of Masonic building in Colon; similar work in three-story concrete apartment building located at corner of Front and Eleventh Streets, Colon, and in the Colon passenger station. Also dismantling at Culebra, transporting to Gatun, and reerecting four frame buildings for officers' quarters; moving three cottages and two 2-story, type 18 buildings at Toro Point to flank and rear of gun battery.

#### GENERAL BUILDING OPERATIONS.

The construction of each building was carried on under what may be termed the single unit organization, as outlined in last year's report. The continuation of this method of work, started during the fiscal year 1915 as a departure from the previous method of swinging different gangs from building to building, seems justified by the results obtained.

In order to obtain competition and to ascertain to what degree, if any, the contract system would prove cheaper than doing the work by force account, contracts were let for the construction of four 4-family frame houses and two 4-family concrete houses. The lowest bid received for the frame house was considered too high under the circumstances and was thrown out. Subsequently the bidder informally offered to reduce his figure per house approximately \$200, and accordingly contract was entered into with him. The same party was also given the contract for the concrete quarters, for which he was likewise the lowest bidder. Simultaneously with the construction of these buildings by contract several buildings of identical types were constructed in the same vicinity by force account. Special effort was made to insure correct distribution of costs on all buildings so that the basis for comparison of costs between contract and force account would be a just one. It developed that the frame buildings cost, under the contract system, on an average of \$696 per building more than those built by force account. The difference was not so marked on the concrete buildings, but in this instance it was again greater. The table following gives the actual costs and differences for the two methods.

By force account.				By contract.			
Number of buildings.	Class of buildings.	Total cost.	Average cost.	Number of buildings.	Class of buildings.	Total cost.	Average cost.
11	4-family frame.....	\$54,972	\$4,997	4	4-family frame.....	\$22,772	\$5,693
8	4-family concrete...	166,366	20,796	2	4-family concrete...	45,335	22,667

The frame buildings constructed by force account cost 12 per cent less than those built by contract, and the concrete buildings cost 8 per cent less than those built by contract.

Subsequent to the completion of the above contracts, all buildings have been built by force account exclusively.

The construction of buildings with bearing walls of hollow concrete blocks or terra cotta was discontinued. All concrete buildings built during the year were designed with poured reinforced concrete main walls and floors. Hollow concrete blocks were used only for interior partition walls and as such carried no part of the building load. The indications are that, aside from being a more durable and safer form of construction, this design is cheaper than the all-block plaster and stucco system.

As stated in last year's report, the use of hard finished white plaster was considered less satisfactory than plain cement plaster painted, and was therefore abandoned. The interior of all concrete buildings constructed during the fiscal year were finished in cement, the surface treated chemically and painted in colors most suitable. Experience indicates that such a wall is less expensive in first cost and maintenance, and, due to its hardness, more serviceable.

The use of corrugated iron for roofs of frame buildings has been standard on the Isthmus from the beginning of canal operations. For temporary frame buildings that may be subject to removal and reerection, this material is without doubt the most satisfactory, but for buildings of a semipermanent character, designed to stand during the life of the frame, 12 to 15 years at least, corrugated iron is not so satisfactory in that it is a source of expense for upkeep, is unsightly, and deteriorates rapidly. This latter is particularly true when it is exposed to the salt air, as along the Cristobal and Colon beach. Considerable thought has been given to this question, and in an endeavor to find some substitute several different classes of roofing material have been tried, viz, asbestos cement shingles, corrugated asbestos cement board, and asphalt shingles. The first two materials meet the durability requirements and eliminate the cost of maintenance, but they are not pleasing in appearance and are high in first cost. The red asphalt shingle was placed on two buildings in January, 1916, for trial. Certain special experiments were also made with the shingle, and the results seem to indicate that it is entirely satisfactory for frame building roofs, subject to the climatic and other special conditions obtaining on the Isthmus. Further, at the present market price of corrugated iron, the asphalt shingle, together with its supporting sheathing, is approximately \$5 per square cheaper than the iron, and at the price of iron before the war the costs are approximately equal, considering the current shingle price.

Accordingly, authority was given to adopt the red asphalt shingle for all frame buildings to be constructed during the year 1916.

The manufacture of hollow concrete blocks was continued at the Corozal block plant until December, 1915, at which time it was closed down. The change in design of concrete buildings eliminated the necessity for blocks in larger sizes than 3 by 12 inches and 4 by 12 inches, and arrangements were therefore made to consolidate and reduce the size of the plant. Two of the 8-inch machines were altered into 4-inch machines, and the plant was made ready to start operations at any time the stock of blocks became depleted.

The table following gives the size, number, and unit costs of blocks for the months of July to December, inclusive:

Month.	Size.	Number.	Unit cost.	Total cost.
July, 1915.....	4 by 12 by 12	36, 210	\$0.0815	\$2,950.16
	6 by 12 by 12	5,980	.1205	720.66
Total.....		42,190	1.0870	3,670.82
August, 1915.....	4 by 12 by 12	27,841	.0837	2,331.40
	6 by 12 by 12	9,889	.1239	1,224.90
Total.....		37,730	1.0942	3,556.30
September, 1915.....	3 by 12 by 12	11,401	.0606	691.90
	4 by 12 by 12	23,097	.0742	1,725.17
	6 by 12 by 12	11,065	.1104	1,222.49
Total.....		45,563	1.0798	3,639.55
October, 1915.....	3 by 12 by 12	10,922	.0692	755.76
	4 by 12 by 12	19,140	.0852	1,630.04
	6 by 12 by 12	4,665	.1260	612.85
Total.....		34,927	1.0859	2,998.65
November, 1915.....	3 by 12 by 12	8,778	.0742	652.09
	4 by 12 by 12	14,951	.0914	1,366.97
Total.....		23,729	1.0850	2,019.06
December, 1915.....	3 by 12 by 12	602	.1823	109.77
	4 by 12 by 12	1,112	.2244	249.57
Total.....		1,714	1.2096	359.34

<sup>1</sup> Indicates average cost and includes approximately \$0.02 plant arbitrary.

#### COMPARATIVE COSTS.

The division is constantly called upon to furnish estimates of costs for buildings of all sizes and character. These estimates are generally required before the designs can be made and must be based on merely the over-all dimensions and a small amount of data of the most general scope as to the class of material to enter into the structure. Such estimates compel the use of the unit cost per cubic foot volume of the building. While this method may give reasonably accurate estimates if correct data is available for similar buildings previously constructed, it more often leads to erroneous results, due to lack of information as to the base used for figuring the cube of other buildings; cost of labor; cost of material and other charges; lack of description of grade of material in building; absence of description of foundation; and lack of data regarding material handling cost. This last item, due to location, often amounts to as high as 11 per cent of the total cost of the building. Such erroneous estimates may give the corresponding erroneous impression of economy and good management, or vice versa, accordingly as the building is built for less or more than the estimate.

With a view of gradually compiling as complete data as possible of all classes and types of buildings constructed by the division, it has been the endeavor to keep a comprehensive and detailed distribution of costs for each building. The following table of unit costs is based on such costs of 35 groups of buildings completed during the fiscal year, covering a total of 102 buildings.

The cube of all frame buildings is the product of the extreme outside wall dimensions (over porches) and the height from the bottom of the sill to a point midway between the upper ceiling and the ridge of the roof, or to the upper side of the roof if flat. For concrete buildings it is the product of the extreme outside wall dimension (over porches) and the height from the finished ground level to the center of the roof, as indicated for frame buildings. This applies to all concrete buildings having standard spread footings placed not to exceed 2 feet below ground level. In cases of buildings having special foundations, pile or other type, the cost of this is shown separately as a percentage of the total unit cost which is based on the given standard cube rule above.

Table of comparative unit costs of buildings.

Item.	Name of building.	Number of buildings used as base for estimate.	Division cost (average per building).			Cubic contents (feet).	Unit cost, labor.	Unit cost, material and overhead charges.	Unit cost, total.	Description of design.	Percentage charges, average per building.	Percentage handling to total.	Unit cost chargeable to handling.
			Labor.	Material and overhead charges.	Total.								
1	Type No. 17, revised quarters.....	10	\$819.33	\$1,313.09	\$2,132.42	23,197	\$0.0353	\$0.0566	\$0.0919	Frame, unceiled, wood-post foundations, corrugated iron roof.	\$113.96	5.30	\$0.0049
2	Type No. 14, revised quarters.....	12	1,607.43	3,382.71	4,990.14	60,412	.0266	.0560	.0826	do.	117.55	2.36	.0019
3	House, type No. 4, revised.....	6	1,406.23	3,350.50	4,846.73	55,293	.0271	.0606	.0877	Frame, 2 rooms ceiled, balance unceiled; wood-post foundations, corrugated iron roof.	184.33	3.80	.0033
4	Silver, married apartments, Pedro Miguel.	7	1,662.04	3,513.86	5,175.90	86,111	.0193	.0408	.0601	Frame, unceiled, wood-post foundations, corrugated iron roof.	80.37	1.55	.0009
5	Bachelor quarters for marine division.	1	2,727.61	4,192.94	6,920.55	79,027	.0345	.0531	.0876	do.	150.10	2.17	.0019
6	Permanent quarters, 2-family, type "A."	2	5,491.58	9,723.15	15,214.73	64,403	.0853	.1510	.2363	Cement block and stucco, walls and partitions, 2-story and basement, frame roof, Spanish red tile.	1,156.47	7.60	.0180
7	Permanent quarters, 4-family, type "B."	9	8,437.57	12,269.16	20,706.73	114,275	.0738	.1074	.1812	do.	1,462.35	7.06	.0128
8	Permanent bachelor apartments, Ancon.	137	789.44	31,349.81	69,139.25	263,881	.1432	.1188	.2620	3-story reinforced concrete exterior walls and floor, cement-block partitions, cement and plaster, oil painted, Spanish red tile, frame roof.	5,455.88	7.89	.0207
9	New Ancon hospital, crematory.....	1	3,100.00	3,100.00	6,200.00	20,457	.1514	.1514	.3030	1-story, reinforced concrete walls, floor, and roof, special chimney.	889.85	11.29	.0842
10	Pacific terminal office building.....	133	138.63	37,456.14	70,594.76	303,471	.1092	.1234	.2326	3-story, reinforced concrete bearing walls and floor, cement-block partitions, cement plaster, oil painted, frame roof, Spanish red tile, steel pipe, concrete fill foundations, average length 70 feet.	2,809.26	3.98	.0063
11	Ice and cold-storage plant, Balboa.	155	765.00	74,918.70	130,683.79	526,366	.1059	.1423	.2482	2-story, reinforced concrete floors, walls, and roof, steel pipe, concrete-filled foundations, average length 40 feet, main rooms heavily insulated.	6,994.26	5.35	.0133
12	Ancon Hospital, group No. 4.....	164	932.98	64,240.52	129,182.50	477,382	.1360	.1346	.2706	2-story and basement, reinforced concrete bearing walls and floors, cement-block partitions, cement plaster, oil painted, Welch tile floors, concrete pier foundations, average depth 16 feet, with part resting on creosoted piles, frame roof, Spanish red tile.	10,011,882.41	9.20	.0249



13	Colon Hospital.....	187, 337, 78 84, 831, 92, 172, 169, 70, 673, 280	.1297	.1290	.2557	2-story, reinforced concrete bearing walls and floors, cement-block partitions, cement plaster, oil painted, Welch tile and white alabaster tile floors, frame roof, Spanish red tile, floating mat foundations.	6, 360, 81	3.69	.0094
14	Staff quarters, revised, type No. 8.	5 3, 345, 71	.0465	.0646	.1111	2-story, frame, wood-post foundations, ceiled downstairs only, asbestos cement, French pattern tile.	643.89	8.05	.0089
15	Staff quarters, revised, type No. 20.	3 3, 201, 69	.0599	.0754	.1353	do.	582.32	8.05	.0108
16	Staff quarters, revised, type No. 21.	2 2, 767, 94	.0729	.0828	.1557	do.	519.63	8.78	.0137
17	Barracks, Corozal.	1 3, 507, 75	.0254	.0506	.0760	2-story frame, unceiled, wood-post foundations, frame roof, with corrugated asbestos cement board.	260.55	2.48	.0019
18	Fortification reserve equipment storehouse, Corozal.	1 2, 220, 57	.0881	.1038	.1919	1-story, reinforced concrete bearing walls and floors, cement-block partitions, cement plaster, Muresco paint, frame roof, cement asbestos corrugated board.	329.77	6.81	.0130
19	Ordnance storehouse, Corozal.....	1 872, 13	.0218	.1290	.1508	1-story frame, wood-post foundations, frame roof, cement asbestos corrugated board, floors 250 square feet live load.	198.02	3.28	.0049
20	Army buildings, barracks.....	4 14, 458, 39	.0435	.0554	.0989	2-story, unceiled concrete bearing walls, reinforced concrete beam supporting wooden floors, surface foundations, frame roof, Spanish red tile, wooden partitions.	1,840.77	5.62	.0056
21	Storehouse, Fort Amador.....	1 11, 072, 28	.0765	.1081	.1846	2-story, unceiled concrete bearing walls, reinforced concrete beam supporting wooden floors, surface foundations, frame roof, Spanish red tile, wooden partitions.	2,305.89	8.63	.0139
22	Storehouse, Toro Point.....	1 13, 957, 75	.0964	.1224	.2188	2-story, unceiled concrete bearing walls, reinforced concrete beam supporting wooden floors, floated mat foundations, corrugated asbestos cement board, frame roof.	3,164.43	9.99	.0219
23	Storehouse, Naos Island.....	1 110, 630, 81	.0723	.0762	.1485	2-story, unceiled concrete bearing walls, reinforced concrete beam supporting wooden floors, floated mat foundations, corrugated asbestos cement board, frame roof.	1,757.92	8.04	.0119
24	Storehouse, Margarita Island.....	1 7, 244, 78	.0468	.0688	.1156	2-story frame, floated concrete mat foundation, wooden posts, ceiled downstairs, unceiled upstairs, corrugated asbestos cement board.	818.64	4.57	.0053
25	Headquarters building, Margarita Island.	1 13, 820, 22	.0443	.0544	.0987	2-story frame, unceiled, spread concrete foundations, concrete posts, roof corrugated asbestos cement board.	1,163.18	3.78	.0037
26	Barracks, Margarita Island.....	2 10, 565, 84	.0359	.0489	.0848	do.	1,079.97	4.22	.0037
27	Type "E2" frame house, Margarita Island.	8 2, 043, 74	.0341	.0662	.1293	2-story, frame, floated concrete mat foundations, wooden posts, ceiled downstairs, unceiled upstairs, corrugated asbestos cement board.	210.37	4.62	.0036
28	Frame house, type No. 3, Margarita Island.	1 3, 628, 71	.0465	.0605	.0970	do.	247.99	3.13	.0030
29	Frame house, type No. 20, Margarita Island.	3 2, 643, 82	.0569	.0732	.1301	do.	247.09	4.09	.0053
30	Type No. 14 house.	2 3, 177, 45	.0326	.0770	.1296	do.	222.32	2.84	.0037
31	Coast Artillery post, 4-family, non-commissioned officers' quarters.	3 3, 864, 12	.0693	.1045	.1738	2-story, cement block and stucco walls, concrete floors, frame roof, Spanish red tile.	706.97	5.79	.0101

Table of comparative unit costs of buildings—Continued.

Item.	Name of building.	Number of buildings used as base for estimate.	Division cost (average per building).			Cubical contents (feet).	Unit cost, labor.	Unit cost, material and overhead charges.	Unit cost, total.	Description of design.	Percentage chargeable to special foundations.	Handling charges, average per building.	Percentage handling total.	Unit cost chargeable to handling.
			Labor.	Material and overhead charges.	Total.									
32	Coast Artillery post, commanding officers' quarters.	2	\$5,275.07	\$8,647.88	\$13,922.95	60,886	\$0.0866	\$0.1420	\$0.2286	2-story, cement block and stucco walls, concrete floors, frame roof, Spanish red tile, white plaster.	....	\$437.63	3.14	\$0.0072
33	Coast Artillery post, 2-family captains' quarters.	3	5,570.39	9,234.85	14,805.24	78,487	.0710	.1177	.1887	do.	....	899.32	6.07	.0115
34	Permanent quarters, 4-family, type "B."	2	7,523.50	12,858.78	30,382.28	114,275	.0658	.1126	.1784	do.	....	980.42	4.71	.0084
35	Pacific terminal laundry.	1	26,500.00	46,500.00	73,000.00	840,000	.0315	.0553	.0868	1-story, reinforced concrete walls, floors, footings, steel roof, corrugated asbestos cement board, part floor reinforced concrete beams, wooden joists and floats.	....	4,446.81	6.46	.0056
36	Office and store building, Cristobal coaling plant.	1	7,051.80	14,358.65	21,410.45	93,307	.0736	.1539	.2295	1-story, reinforced concrete walls, floors, and footings, steel roof, corrugated asbestos cement board supporting sawdust concrete, Ludowici Spanish red tile.	....	505.43	2.36	.0054
		103												

The cube of all frame buildings is the product of the extreme outside wall dimensions (over porches) and the heights from the bottom of the sill to a point midway between the upper ceiling and the ridge of the roof, or to the upper side of the roof, if flat. For concrete buildings it is the product of the extreme outside wall dimension (over porches) and the height from the finished ground level to the center of the roof as indicated for frame buildings. This applies to all concrete buildings having standard spread footings placed not to exceed 2 feet below ground level. In cases of buildings having special foundations, pile or other type, the cost of this is shown separately as a percentage of the total unit cost, which is based on the given standard cube rule above.

## NEW ANCON HOSPITAL.

*Group 4, section A.*—On May 1, 1916, the first ward group, known as section "A," of the new Ancon Hospital was completed. The building, designed on the pavilion system, comprises three buildings, each two stories in height. The two ward buildings, 40 by 138 feet, have been designed as large wards, accommodating 29 patients in each ward, and these buildings have a porch entirely surrounding them. The service section, 32 by 92 feet, connecting these two ward groups, provides toilet accommodations, dining room, nurses' room, and special rooms on each floor, and a kitchen has been provided on the second floor, with dumb-waiter service to the first floor and basement.

All of the exterior and interior walls, excepting nonsupporting interior walls less than 6 inches thick, have been made of reinforced concrete, and all others built up of cement blocks with a hard, smooth cement plaster finish. All floor slabs have been constructed of reinforced concrete, and most of the rooms have been provided with red or white tile floors. All of the interior walls and ceilings have been treated with an enamel washable paint, which gives a pleasing effect to the interior and makes a more sanitary building.

The roof, of yellow-pine construction, has been covered with a red vitreous tile, and suitable copper ventilators have been arranged to keep a good circulation of air throughout the roof space.

## COLON HOSPITAL.

During the month of June, 1915, building operations were started on the new two-story hospital at Colon, and on April 10, 1916, the building was completed. The building is situated within the old hospital grounds on the Beach Road, and commands an unobstructed view of the Atlantic Ocean.

In order to meet the local climatic conditions the pavilion scheme was adopted, which divides the group into four distinct units with intercommunicating passageways. The central unit, in which the operating suite and administrative offices are located, is about 45 feet wide by 53 feet 6 inches long, with an extension in front 24 feet by 20 feet 4 inches, which forms a covered entrance way and makes provision for an operating room on the second floor with exposure on three sides.

The ward buildings, approximately 40 by 130 feet on either side of the central unit, have been divided into various wards and private rooms, with a total capacity of 50 patients. In addition, the dispensary, X-ray room, pharmacy, and emergency ward occupy a portion of the first floor of the right wing.

The general service building, 41 by 83 feet, comprising the kitchen, dining room, helpers' quarters, etc., also has a central location, directly in the rear of the administration unit, which makes the portion accessible and convenient to all other parts of the hospital.

All exterior, porch, and intermediate walls 6 inches and over have been constructed of reinforced concrete, and interior walls having thickness less than 6 inches built up of cement blocks and covered with a smooth, hard cement finish. The roof framing has been constructed of yellow pine, with vitreous roof tile covering, Spanish pattern.

All floors have been laid with vitreous red or white tile, depending upon the purpose of the room, and all walls and ceilings painted with an enamel washable paint.

## PACIFIC TERMINAL BUILDING.

The new Pacific terminal office building constructed during the past fiscal year occupies a prominent site in Balboa in close proximity to the piers and docks of the Pacific terminal of the canal. The building is a three-story reinforced concrete structure, with red vitreous tile roof, supported by wooden trusses of yellow pine. Porches have been planned on three sides of the building, and the entire building covers an area of 147 feet 8 inches by 42 feet 8 inches. On account of the very poor bearing value of the soil in this particular site, pipe piles filled with concrete were driven to support the superstructure. For the most part the first floor has been assigned to the general offices of the receiving and forwarding agent of the Panama Railroad Co. and the entire third floor to the port captain's division. Besides the regular offices required by the port captain, a lounging room and pilots' dormitories have been provided. In order to partially meet the demand for offices by various steamship companies using the canal, the entire second floor has been divided into offices which may be rented individually or in suites.

Red vitreous tile has been laid in all corridors and white tile in the toilets, and walls and ceilings treated in the customary manner with enamel washable paint.

## BACHELOR QUARTERS.

This building is located in Ancon on the Zone road which divides Panama City from the Ancon district. The building, 121 feet 7 inches long by 48 feet 6 inches wide, three stories high, of reinforced concrete construction with red tile roof, provides accommodations for 45 bachelors and affords each man certain comforts and conveniences which have not been enjoyed heretofore on the Isthmus. Each room has been provided with a built-in dry closet, lavatory, medicine closet, and telephone connection.

The central corridor through the building affords access to the various rooms and eliminates the general usage of the porches as a passageway.

Bubbling ice-water drinking fountains have been installed in the corridors of each floor, fed from a central plant. Convenient and ample toilet accommodations have been provided.

## NEW ANCON HOSPITAL.

*Dispensary and admitting office.*—Plans are being prepared for the new Ancon Hospital dispensary and admitting office. The new building will occupy the present site of the board of health building in Ancon. The building will cover an area approximately 50 by 90 feet, two stories in height, of reinforced concrete construction. All nonsupporting interior walls having a thickness less than 6 inches will be built of cement blocks and covered with a smooth, hard cement finish. The roof will be constructed of wood and covered with red tile, Spanish pattern.

The first floor will be occupied by the admitting office and dispensary, and will provide consultation, examination, dressing, and waiting rooms for both gold and silver employees. A large drug room, storeroom, and laboratory have also been arranged for on this floor. A roadway running around the building provides access to the dressing rooms for ambulance cases.

There will be no interior communication between the first and second floors. Separate entrances and staircases lead to the second floor, where two dental suites and living quarters for two doctors, three nurses, and orderlies have been provided.

The dental suite will comprise a waiting room, operating room, laboratory, and rest room, and in one of the dental suites an extra operating room has been arranged for. Each room of the doctors' and nurses' quarters will have a lavatory, dry closet, telephone connection, and ample porch space, which will make very desirable quarters for these men.

*Laboratory building.*—Construction work on the new laboratory building in Ancon will be started July 1, 1916. The building, a two-story reinforced concrete structure, with red tile roof, has been designed in the shape of the letter U, about a courtyard. The building has a frontage of 104 feet 8 inches and a depth of 85 feet 3 inches, and will be provided with a covered passageway to the present crematory building.

Under a portion of the first floor a basement story has been arranged to provide space for various animal rooms and storage. Upon the first floor provision has been made for the chemist, embalmer, library, museum, office, stores, and plague laboratory.

Upon the second floor space has been made for the chief's office, and laboratory, photographer, bacteriologist, entomologist, and pathologist. In order to keep each unit isolated from its adjoining section, only indirect communication has been provided, by means of a two-storied porch about the courtyard.

In all rooms tile floors will be provided, and, as noted for the other buildings, the walls and ceilings will be painted with a washable paint.

*Ward group No. 5.*—On June 1, 1916, construction work was started on the second ward group of the new Ancon Hospital. This building, which will be two stories in height, will have a general exterior appearance similar to the first ward group, with porches entirely surrounding the ward, in order to conform to the general hospital scheme. As in the previous group, there will be two large buildings, with a connecting service building. The ward buildings, 138 feet 10 inches by 41 feet 6 inches and 122 feet 10 inches by 41 feet 6 inches, have been divided into various wards and private rooms on both floors. Many of the private rooms have been provided with communicating bathrooms, and various small wards, arranged for adults, to accommodate from three to seven persons. The obstetrical suite has been planned on the second floor of one of these wards, and nursery and children's ward provided.

The service building, approximately 54 feet long, will contain the various accessory rooms, such as kitchens, dining room, nurses' rooms, private rooms, etc. An electric elevator will be installed in this section.

As in the previous ward group, all exterior walls and interior bearing walls will be of reinforced concrete, and all other interior partitions of cement block plastered with a cement finish. All floors will be laid with red or white vitreous tile, and the walls and ceilings painted with an enamel washable paint.

Electric dumb-waiter service will be provided between the kitchen and basement, and laundry chutes will connect all orderlies' rooms with the basement.

## FORCE.

On July 1, 1915, the force averaged 2,100 men—166 men on the gold roll and 1,934 men on the silver roll. This was increased to a maximum in August of 2,387—181 on gold roll and 2,206 on silver roll. At the end of the fiscal year, June 30, the force totaled 1,812—169 on the gold roll and 1,643 on the silver roll.

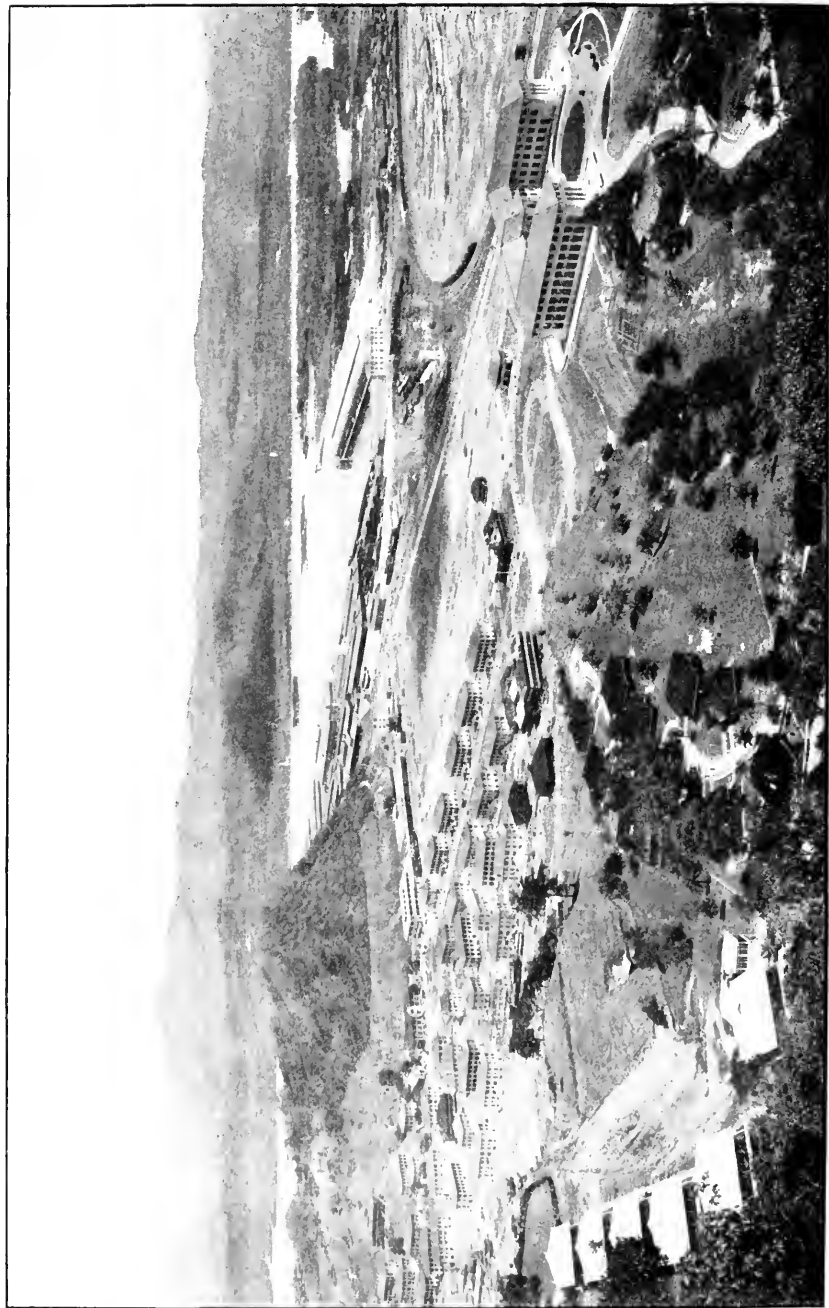
Respectfully submitted.

GEO. M. WELLS,  
*Resident Engineer.*

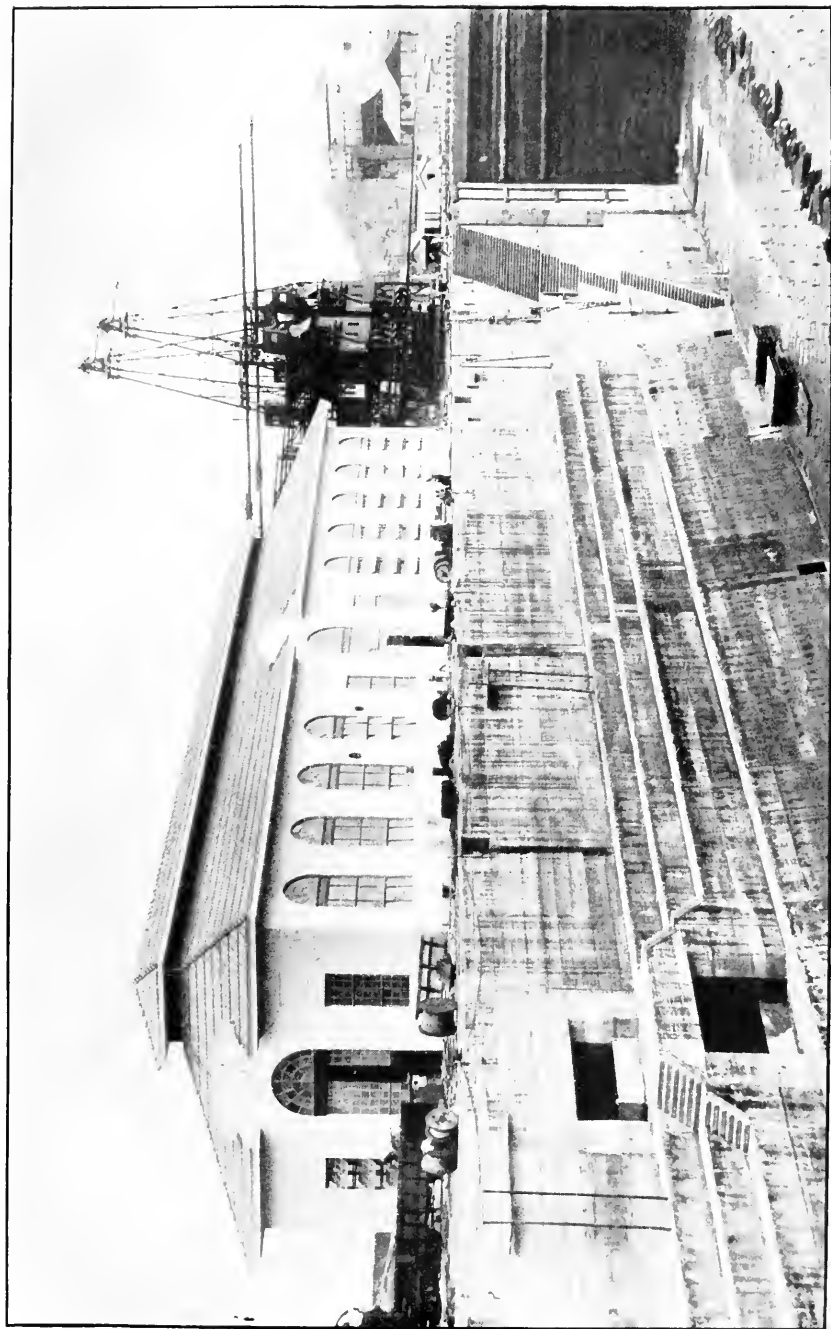
Maj Gen. GEO. W. GOETHALS, United States Army,  
*Governor The Panama Canal, Balboa Heights, Canal Zone.*



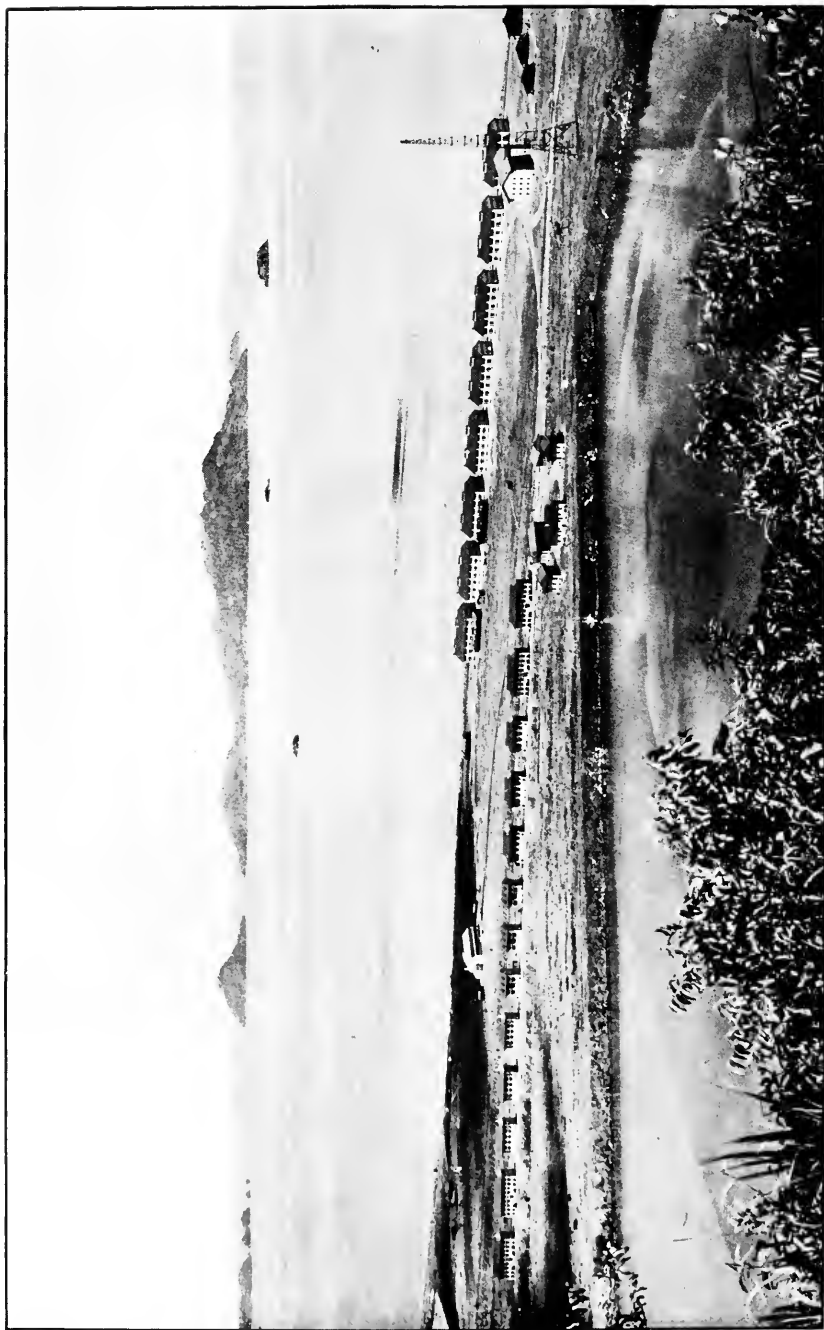
BALBOA HEIGHTS FROM ANCON HILL.







NEW DRY DOCK, BALBOA. AIR COMPRESSOR AND PUMP BUILDING.



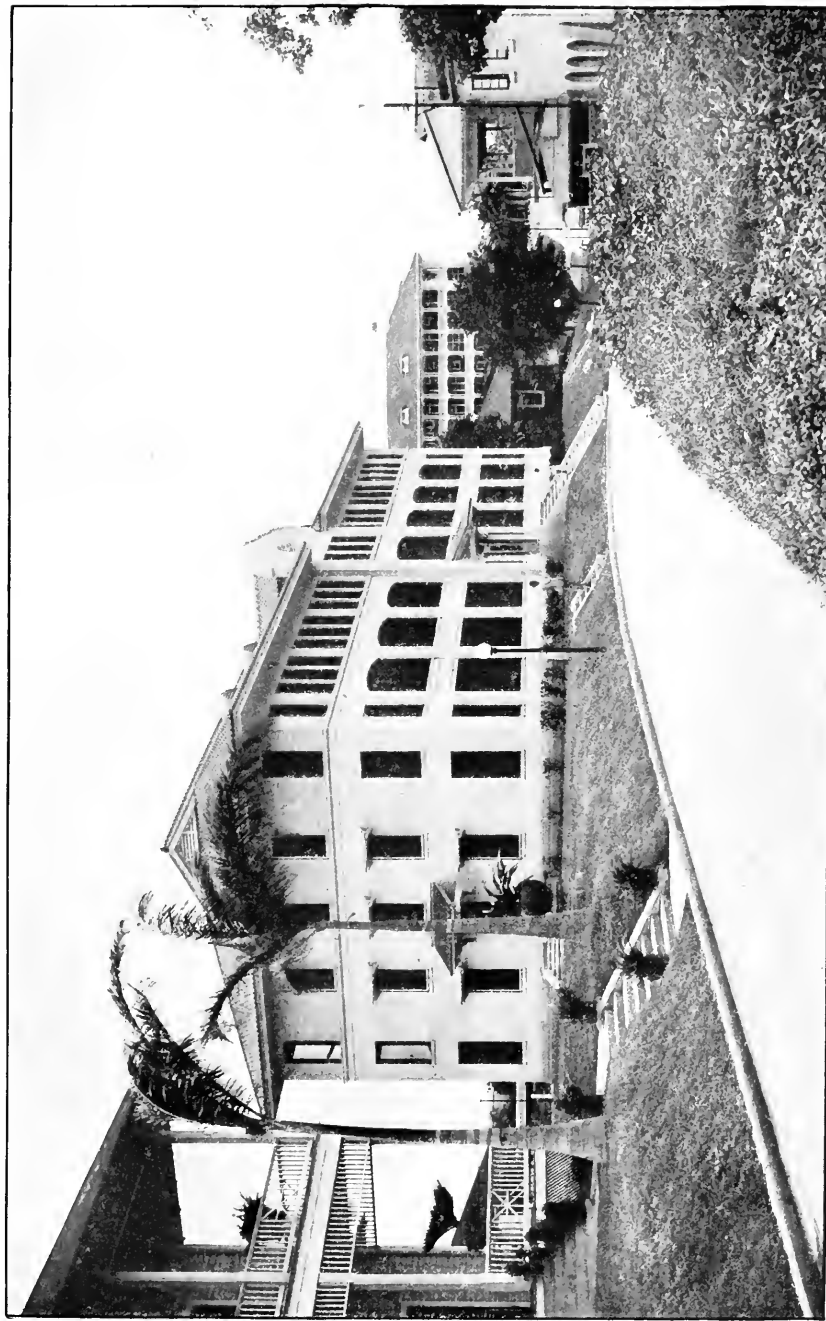
FORT GRANT. COAST ARTILLERY POST.



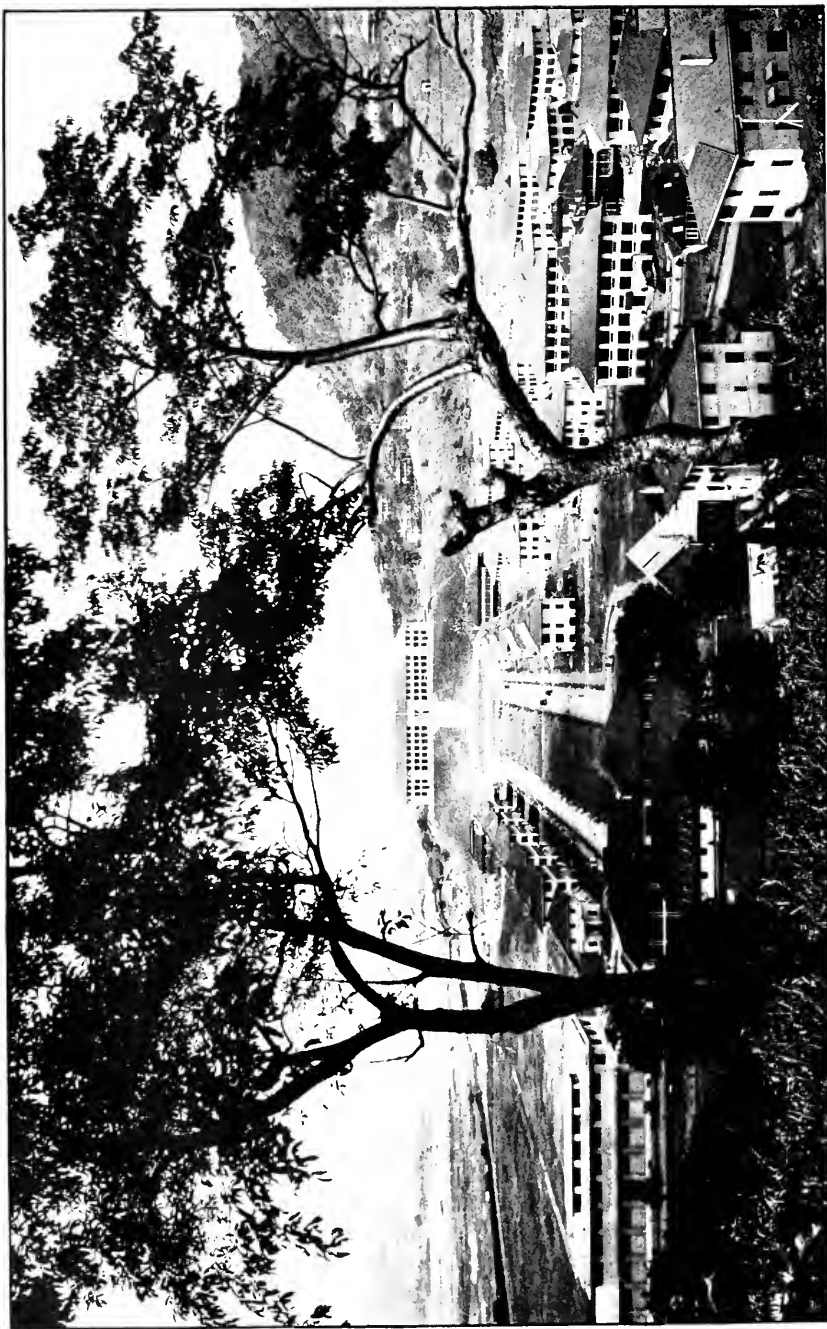
PACIFIC TERMINAL BUILDING, BALBOA, CANAL ZONE.



NEW STEAM LAUNDRY, ANCON, CANAL ZONE.



NEW CONCRETE QUARTERS FOR BACHELORS, ANCON, CANAL ZONE.



BALBOA PRADO FROM SOSA HILL.

## APPENDIX E.

### REPORT OF THE RESIDENT ENGINEER, DREDGING DIVISION, DEPARTMENT OF OPERATION AND MAINTENANCE.

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#### PARAISO, CANAL ZONE.

SIR: I have the honor to submit the following report of operations in the dredging division during the fiscal year ended June 30, 1916:

#### DIVISION ORGANIZATION.

The division is divided into two districts, the first district embracing all dredging operations in the Pacific entrance, Miraflores Lake, and Gaillard Cut; the second district, all dredging operations in the Atlantic entrance and Gatun Lake to Gamboa Bridge.

#### DREDGING.

The following dredges were at work during the year:

The seagoing suction dredge *Culebra* was engaged in deepening the channel between stations 1470 and 1890, Gaillard Cut; deepening the slip along Pier No. 18, Balboa; excavating along the toe of the dry-dock cofferdam at Balboa, and was used as a scow for dredges No. 83 and No. 86 during an emergency at Culebra slide in May and June, 1916.

The seagoing suction dredge *Caribbean* was not operated as a dredge during the year, but was laid up at Paraiso from July 1, 1915, to October 16, 1915; used as a compressor plant for drilling operations at Culebra slide from October 17, 1915, to May 16, 1916; converted into a cattle boat and turned over to the Panama Railroad commissary department on May 23, 1916.

The 20-inch pipe-line dredge No. 4 was engaged during the year pumping the core fill into the east breakwater at Coco Solo; excavating in the vicinity of the new Cristobal coaling station; deepening the berths at Piers No. 7 and No. 8, Cristobal, and at the old coal dock near Mount Hope Dry Dock.

The 20-inch pipe-line dredge No. 82 was engaged during the entire year reclaiming sand and gravel from the old bed of the Chagres River, through Gatun Lake, above Gamboa.

The 20-inch pipe-line dredge No. 83 was engaged during the year excavating the coal storage basin at the Cristobal coaling station, maintaining the required depth in Cristobal Harbor, deepening the channel at Culebra slide and in Miraflores Lake.

The 20-inch pipe-line dredge No. 84 (*Sandpiper*) was engaged during the year excavating the berths and channels at the Cristobal coaling station, placing the core fill in the east breakwater at Coco Solo, deepening Cristobal Harbor, excavating trenches for the oil, water, and cable crossings, Cristobal Harbor, and deepening the channel at Culebra slide.

The 20-inch suction dredge *No. 85* was engaged during the year excavating Balboa Harbor, deepening the berths along Piers No. 14 and No. 18, Balboa, filling around the fortifications at Toro Point, sluicing at Culebra slide, deepening the channel in the Atlantic and Pacific entrances, sluicing mud from under the coal reloader wharf at Balboa, pumping water to fill the dry dock entrance basin at Balboa, and was laid up at Gamboa from May 24, 1916, to the end of the year.

The 20-inch pipe-line dredge *No. 86* was engaged during the year excavating in Balboa Harbor, deepening the berths around Pier No. 18 at Balboa, excavating at Cucaracha and Culebra slides in Gaillard Cut, and filling the swamp areas in and around Paraiso.

The 15-yard dipper dredge *Cascadas*, built by the Bucyrus Co., of South Milwaukee, in 1915, is an improved model of the sister dredges *Gamboa* and *Paraiso*. All the working parts are interchangeable with these dredges. The hull is of steel and has a length of 144 feet, 56 feet beam, 16 feet 6 inches deep, with a minimum draft of 8 feet. The forward spuds are operated by an improved overhead handling device and the engine room is fitted with a 15-ton overhead traveling crane.

The dredge arrived at Cristobal on October 21, 1915, was towed to Gamboa, and assembled October 22-30, went into commission on October 31, 1915, and was operated for the remainder of the year in maintaining, widening, and deepening the channel at Culebra slide, in Gaillard Cut.

The 15-yard dipper dredge *Gamboa* was operated the entire year in Gaillard Cut maintaining, widening, and deepening the channel at Culebra slide.

The 15-yard dipper dredge *Paraiso* was operated the entire year in Gaillard Cut maintaining, widening, and deepening the channel at Culebra slide.

The 5-yard dipper dredge *Cardenas* was engaged in maintaining and deepening the channel at Culebra slide from July 1 to September 30, 1915; retired from service on October 1, 1915; placed in commission at Culebra slide from January 4 to 24, 1916, and retired for the remainder of the year.

The 5-yard dipper dredge *Chagres* was operated at Cucaracha and Culebra slides, in Gaillard Cut, from July 1 to October 31, 1915, and retired from active dredging service from November 1, 1915, to June 30, 1916.

The 5-yard dipper dredge *Mindi* was operated at Cucaracha and Culebra slides, in Gaillard Cut, from July 1 to November 3, 1915, and retired from active dredging service from November 1, 1915, to June 30, 1916.

The seagoing ladder dredge *Corozal* was engaged during the entire year in maintaining, widening, and deepening the channel at Cucaracha and Culebra slides, in Gaillard Cut.

The French ladder dredge *No. 1* was engaged during the year excavating gravel from the Chagres River gravel beds from July 1, 1915, to June 25, 1916, and in maintaining and deepening the channel at Culebra slide from June 26 to 30, 1916.

The French ladder dredge *No. 5* was engaged during the year excavating rock and stiff clay in the Pacific entrance, deepening the channel through Gaillard Cut and at Culebra slide, excavating from



alongside Pier No. 18, Balboa Harbor, and excavating the cofferdam across the entrance to the Balboa Dry Dock.

The French ladder dredge *Marmot* was engaged during the year excavating the channel and berths at the Cristobal coaling station, deepening the Cristobal approach channel, excavating along the harbor side of the east breakwater in Limon Bay, deepening the channel at Culebra and Cucaracha slides, and clearing the mouth of a culvert under the Panama Railroad near Caimito.

The French self-propelling ladder dredge *Gopher* was operated in the Pacific entrance from July 1 to August 15, 1915, on which date it was permanently retired from service.

The drill barge *Teredo No. 2* was operated in Pacific entrance between stations 2098 and 2125 east, at Cucaracha and Culebra slides in Gaillard Cut, and in the inner harbor at Balboa.

The rock breaker *Vulcan* was operated on the rock shoals between stations 2110 and 2167, Pacific entrance, in Balboa Harbor, and along the Panama Railroad steel wharf at Balboa.

The hydraulic grader *No. 1* was engaged during the year in sluicing at Culebra slide, cutting drainage ditches at east and west Culebra and Cucaracha slides, excavating for the Rio Grande spillway, sluicing mud from beneath Pier No. 18, Balboa, and furnishing steam and water to the drills at Culebra slide: sluicing down and grading the slide at station 1559-1567 west.

The hydraulic grader *No. 2*, built at Paraiso, went into commission in December, 1915, and was engaged in sluicing and grading operations at Culebra slide for the remainder of the year.

The hydraulic grader *No. 3*, built at Paraiso, went into commission in December, 1915, at Culebra slide, and was engaged in sluicing operations during the remainder of the year.

The floating compressor plant, built at Paraiso in 1916, was placed in commission at Culebra slide on May 17, 1916, and was operated to supply air to the drills at work upon the slides for the remainder of the year.

The following table shows the output of all dredges operated during the year, with total and unit costs of same:

TABLE NO. 1.—Output of all dredges with total and unit costs.

Dredge.	Output in cubic yards.			Cost.	Unit cost.
	Earth.	Rock.	Total.		
Culebra.....	1,062,209	7,316	1,069,525	\$263,367.57	\$0.24625
No. 4.....	204,520	265,005	469,525	186,264.04	.39671
No. 82.....	117,023	.....	117,023	72,224.84	.61718
No. 83.....	221,188	161,726	382,914	148,762.86	.38850
No. 84.....	180,784	173,711	354,495	142,399.30	.40170
No. 85.....	827,342	4,187	831,529	162,588.79	.19953
No. 86.....	763,374	24,374	787,748	260,318.24	.33045
Casadas.....	2,400,492	2,400,492	2,400,492	570,113.33	.23750
Gamboa.....	3,097,226	3,097,226	3,097,226	762,904.83	.24632
Paraiso.....	3,004,104	3,004,104	3,004,104	750,103.25	.24909
Cardenas.....	171,203	171,203	171,203	59,769.10	.34908
Chagres.....	234,131	234,131	234,131	76,459.46	.32657
Mindi.....	228,442	228,442	228,442	90,329.81	.39542
Corozal.....	1,459,312	1,459,312	1,459,312	494,134.53	.33861
No. 1.....	463,377	7,205	470,582	92,587.23	.19675
No. 5.....	132,566	137,964	270,530	104,407.69	.38590
Gopher.....	2,531	13,921	16,452	8,598.42	.40107
Marmot.....	9,983	328,313	338,296	118,116.09	.34915
Total.....	3,984,897	11,718,632	15,703,529	4,363,443.38	.27786
Total, 1915.....	8,057,550	6,271,573	14,329,123	4,067,823.06	.28388

While the above table shows the actual cost of the yardage removed from the canal prism, the cost of the total yardage handled by dredges would be considerably less, as there were 1,124,282 cubic yards rehandled for which no credit was taken upon second handling. The following table shows the total and unit costs of all yardage actually handled by dredges during the year:

TABLE NO. 2.—All yardage actually handled, with total and unit costs.

Dredge.	Primary.	Rehandled.	Total.	Cost.	Unit cost.
Culebra.....	1,069,525	1275,477	1,345,002	\$263,367.57	\$0.19581
No. 83.....	382,914	18,380	401,294	148,762.86	.37071
No. 86.....	787,748	754,849	1,542,597	260,318.24	.16875
Cardenas.....	171,203	995	172,198	59,763.10	.34706
No. 5.....	270,530	70,311	340,841	104,407.69	.30632
Marmot.....	338,296	4,270	342,566	118,116.09	.34480
Total.....	3,020,216	1,124,282	4,144,498	954,735.55	.....
Other dredges.....	12,683,313	.....	12,683,313	3,408,707.83	.....
Total.....	15,703,529	1,124,282	16,827,811	4,363,443.38	.25930

<sup>1</sup> The quantity shown as rehandled by the dredge *Culebra* includes 35,777 cubic yards of material which was pumped into her hoppers by various pipe-line dredges.

The following tables show the monthly output of all dredges, exclusive of the sand and gravel plants:

TABLE NO. 3.—Yardage removed, first district, Pedro Miguel Locks to sea.

Month and year.	Canal prism.			Auxiliary.			Grand total.
	Earth.	Rock.	Total.	Earth.	Rock.	Total.	
1915.							
July.....	13,198	16,329	29,527	64,059	.....	64,059	93,586
August.....	15,780	10,778	26,558	96,094	.....	96,094	122,652
September.....	1,944	8,303	10,247	153,331	300	153,631	163,878
October.....	.....	.....	.....	74,703	.....	74,703	74,703
November.....	.....	.....	.....	2,132	1,513	3,645	3,645
December.....	.....	.....	.....	67,439	3,000	70,439	70,439
1916.							
January.....	40,456	.....	40,456	124,310	4,900	129,210	169,666
February.....	32,344	.....	32,344	37,446	1,391	38,837	71,181
March.....	.....	.....	.....	122,587	.....	122,587	122,587
April.....	8,655	.....	8,655	45,273	.....	45,273	53,928
May.....	17,256	3,750	21,006	103,094	5,000	108,094	129,100
June.....	8,552	.....	8,552	15,818	17,450	33,268	41,820
Total.....	138,185	39,160	177,345	906,286	33,554	939,840	1,117,185

TABLE NO. 4.—*Yardage removed, first district (Gaillard Cut), Pedro Miguel Locks to Gamboa Dike.*

Month and year.	Canal prism.			Auxiliary.			Grand total.
	Earth.	Rock.	Total.	Earth.	Rock.	Total.	
1915.							
July.....	193,938	498,171	692,109	.....	.....	.....	692,109
August.....	307,315	684,564	991,879	.....	.....	.....	991,879
September.....	254,287	798,299	1,052,586	.....	.....	.....	1,052,586
October.....	207,778	871,915	1,079,693	.....	.....	.....	1,079,693
November.....	211,317	1,017,413	1,228,730	.....	.....	.....	1,228,730
December.....	148,262	1,007,831	1,156,093	.....	.....	.....	1,156,093
1916.							
January.....	88,273	984,765	1,073,038	.....	.....	.....	1,073,038
February.....	.....	1,039,950	1,039,950	.....	.....	.....	1,039,950
March.....	58,096	1,084,738	1,142,834	.....	.....	.....	1,142,834
April.....	184,565	850,143	1,034,708	.....	.....	.....	1,034,708
May.....	98,863	1,035,040	1,133,903	.....	.....	.....	1,133,903
June.....	69,856	999,680	1,069,536	.....	.....	.....	1,069,536
Total.....	1,822,550	10,872,509	12,695,059	.....	.....	.....	12,695,059

TABLE NO. 5.—*Yardage removed, second district.*

Month and year.	Canal prism.			Auxiliary.			Grand total.
	Earth.	Rock.	Total.	Earth.	Rock.	Total.	
1915.							
July.....	45,461	.....	45,461	60,579	103,669	164,248	209,709
August.....	.....	.....	.....	96,489	99,168	195,657	195,657
September.....	.....	.....	.....	9,635	77,519	87,154	87,154
October.....	.....	.....	.....	40,892	54,640	95,532	95,532
November.....	.....	.....	.....	6,104	31,612	37,716	37,716
December.....	.....	.....	.....	59,923	62,065	121,988	121,988
1916.							
January.....	.....	.....	.....	25,197	43,950	69,147	69,147
February.....	.....	.....	.....	36,580	82,130	118,710	118,710
March.....	.....	.....	.....	56,226	57,624	113,850	113,850
April.....	.....	.....	.....	19,361	64,810	84,171	84,171
May.....	.....	.....	.....	33,956	56,659	90,615	90,615
June.....	.....	.....	.....	47,073	39,563	86,636	86,636
Total.....	45,461	.....	45,461	492,015	773,409	1,265,424	1,310,885

On July 1, 1916, there remained to be removed from the canal prism, including siltage, slides, and original material, 6,144,827 cubic yards of earth and 11,082,537 cubic yards of rock. These quantities include 350,000 cubic yards of earth at the Pacific and 400,000 cubic yards of earth at the Atlantic entrances, estimated to cover siltage of the channel from July 1, 1916, to June 30, 1917.

TABLE No. 6.—*Yardage remaining to be removed from the canal prism.*

Location.	Earth.	Rock.	Total.
<i>First district.</i>			
Pacific entrance, construction.....	535, 160	348, 137	883, 297
Pacific entrance, maintenance of channel.....	2, 170, 729	.....	2, 170, 729
Miraflores Lake, construction.....	246, 998	.....	246, 998
Miraflores Lake, maintenance of channel.....	225, 000	.....	225, 000
Gaillard Cut, construction.....	400, 000	716, 200	1, 116, 200
Gaillard Cut, maintenance of channel.....	500, 000	10, 017, 000	10, 517, 000
<i>Second district.</i>			
Gatun Lake, construction.....	51, 000	.....	51, 000
Gatun Lake, maintenance of channel.....	250, 000	.....	250, 000
Atlantic entrance, construction.....	365, 940	1, 200	367, 140
Atlantic entrance, maintenance of channel.....	1, 400, 000	.....	1, 400, 000
Total.....	6, 144, 827	11, 082, 537	17, 227, 364

The following table shows the number of days the dredges were retired for repairs and renewals:

TABLE No. 7.—*Number of days dredges were retired for repairs and renewals.*

Dredges.	Type.	Days out of service.	Remarks.
Caribbean	Seagoing suction dredge .....	365	Retired from dredging services.
Culebra	do.....	11	
No. 4.....	Pipe-line suction dredge.....	39	
No. 82.....	do.....	.....	All repairs made in the field while waiting for barges.
No. 83.....	do.....	45	
No. 84.....	do.....	37	
No. 85.....	do.....	62	
No. 86.....	do.....	10	
Cascadas.....	15-yard dipper dredge.....	2	
Gamboa.....	do.....	18	
Paraiso.....	do.....	16	
Cardenas.....	5-yard dipper dredge.....	297	
Chagres.....	do.....	262	
Mindi.....	do.....	263	
Corozal.....	Seagoing ladder dredge.....	74	
No. 1.....	French ladder dredge.....	2	
No. 5.....	do.....	52	
Gopher.....	French ladder dredge (marine).....	324	Retired from service and dismantled.
Marmot.....	French ladder dredge.....	54	

## SUBAQUEOUS ROCK EXCAVATION.

## FIRST DISTRICT, GAMBOA DIKE TO PANAMA BAY.

During the year 10,945,223 cubic yards of hard and soft rock were<sup>e</sup> removed from the canal prism and Balboa Harbor, as follows: Thirty-nine thousand one hundred and sixty cubic yards from the Pacific entrance, 10,760,056 cubic yards from Culebra slide, 66,635 cubic yards from Cucaracha slide, 45,818 cubic yards from Gaillard Cut, maintenance, and 33,554 cubic yards from Balboa Harbor. Of this amount 68,069 cubic yards were drilled and blasted by the *Teredo No. 2*, 39,044 cubic yards were broken by the rock breaker *Vulcan*, 391,035 cubic yards of rock and boulders too large for the dredges to handle, by hand and tripod drills at Cucaracha and Culebra slides in Gaillard Cut, and 16,800 cubic yards by well drills under the cofferdam at the entrance to the Balboa Dry Dock. The remainder includes rock which had been drilled and blasted in previous years by well drills and material which could be handled by the dredges

without mining. On this work and for dobbing 401,370 pounds of dynamite were used.

The following table shows the location, quantity, method of breaking, and area covered of rock shoals worked, exclusive of the hand and tripod drill work, at Cucaracha and Culebra slides and monthly statement of rock removed by dredges:

TABLE NO. 8.—*Rock removed by dredges.*

Month and year.	Station and method of breaking.		Area covered.	Cubic yards mined.	Amount dredged.
	Teredo.	Vulcan.			
1915.					
July.....	Cucaracha and Culebra slides.	2150 E and Balboa Harbor.	57,241	12,038	514,500
August.....	do.....	do.....	51,908	8,108	695,342
September.....	do.....	2152, 2160, and Balboa Harbor.	50,592	2,369	806,902
October.....	2116, 2119 E.....	2133 E, 2150 E.....	91,116	7,110	871,915
November.....	2116, 2118 E.....	2121, 2132 E, and 2180, 2184 E.	69,479	7,507	1,018,926
December.....	2115, 2117 E, and Culebra slide.	2110, 2120 E, 2130, 2150 E, 2180, 2184 E.	64,186	8,702	1,010,831
1916.					
January.....	Culebra slide.....	2110, 2121 E, 2200, 2210 E.	61,866	12,040	989,665
February.....	do.....	2263 E and P. R. R. Dock.	48,123	10,695	1,041,341
March.....	2098, 2100 E, and Culebra slide.	2265 E and P. R. R. Dock.	33,709	13,146	1,084,738
April.....	Culebra slide.....	2263 E.	26,968	8,235	850,143
May.....	2099, 2103 E, and Balboa Harbor.	2261, 2267 E, P. R. R. Dock.	36,900	12,010	1,043,790
June.....	2102, 2103 E.....	2260, 2270 E.....	28,549	5,153	1,017,130
Total.....			620,637	107,113	10,945,223

## SECOND DISTRICT.

No rock was mined or removed from the canal prism. Dredges removed 501,280 cubic yards of coral and soft rock from the coaling station areas, 353,673 cubic yards of which had been drilled and blasted in previous years by well drills and the drill boat *Terrier*, and 223,152 cubic yards of coral rock at Coco Solo. Three thousand nine hundred and eighty pounds of dynamite were used in dobbing rock and boulders too large for the dredges to handle.

## DREDGING OPERATIONS.

## FIRST DISTRICT.

Dredges were at work throughout the year deepening and maintaining the canal channel at the Pacific entrance, Miraflores Lake, and Gaillard Cut, excavating a total of 12,872,404 cubic yards, as shown in the following table:

TABLE NO. 9.—*Yardage excavated from Pacific entrance, Miraflores Lake, and Gaillard Cut.*

Section.	Excavation, in cubic yards.		
	Construction yardage.	Maintenance yardage.	Total.
Pacific entrance channel.....	48,124	110,619	158,743
Miraflores Lake.....	18,602	.....	18,602
Gaillard Cut.....	264,850	12,430,209	12,695,059
Total, canal prism, first district.....	331,576	12,540,828	12,872,404

Of the material removed from Gaillard Cut, 88 per cent was from Culebra slide, 2 per cent from Cucaracha slide, and 10 per cent from all other slides and canal areas.

The following table shows the distribution of all material removed from Gaillard Cut during the year:

TABLE No. 10.—*Distribution of material removed from Gaillard Cut.*

Location.	Fiscal year.			Total to date.		
	Earth.	Rock.	Total.	Earth.	Rock.	Total.
Gamboa Dike.....				23,856	53,105	76,961
Whitehouse slide E.....		4,045	4,045		4,045	4,045
La Pita slide.....					24,733	24,733
Empire slide.....				3,221	115,516	118,737
Culebra slide (old) <sup>1</sup> .....				28,449	1,061,337	1,089,786
Culebra slide (new) <sup>2</sup> .....	450,085	10,760,056	11,210,141	1,016,098	14,319,953	15,336,051
Cucaracha slide.....	198,215	66,635	264,850	1,324,213	3,292,163	4,616,376
65-foot berm.....					25,730	25,730
Miscellaneous <sup>3</sup> .....	1,174,250	41,773	1,216,023	1,449,377	56,809	1,506,186
Total.....	1,822,550	10,872,509	12,695,059	3,845,214	18,953,391	22,798,605

<sup>1</sup> Prior to Oct. 14, 1914.

<sup>2</sup> Since Oct. 14, 1914.

<sup>3</sup> Small slides and fills in the canal.

Cucaracha slide has been quiescent throughout the year, except for some slight movement (surface) of the softer materials during and immediately following heavy rainfalls, and has a slope of one vertical to four horizontal.

No more serious trouble is anticipated, although it will probably be necessary to remove a considerable quantity of the softer surface materials by sluicing and pipe-line dredge before the final clean-up can be made.

Culebra slide, east and west, has been very active throughout the year. With the exception of August 7 to 10 and September 4 to 9, a channel for commercial shipping was maintained with great difficulty from July 1 to September 18, 1915, on which date a general heavy movement of both banks closed the channel to all but light-draft boats. On September 19 a small island appeared in the channel, caused by an upheaval of the bottom, which stopped all traffic except small boats. The banks continued to move until the island was connected with the east bank, forming a point of land extending over two-thirds of the distance across the channel, and on October 2 the east and west banks met at the water line, elevation + 85, completely closing the canal and re-forming an isthmus. The movement reached its maximum on November 10, at which time the isthmus was 255 feet wide and 65 feet above mean water level in the canal. On December 16, 1915, a channel had been reopened for small tugs and launches, which was gradually widened and deepened until sufficient channel was obtained to resume commercial traffic on April 15, 1916, 216 days after the closing of the canal on September 12, 1915. During the year the area of the slides has increased by 11 acres, due to new breaks developing back of the original slide limits. On July 1, 1916, 16,425,837 cubic yards of material had been removed from the Culebra slides by dredges, and it was estimated that 9,617,000 cubic yards more were in motion toward the canal, which will eventually have to be removed. The canal prism for 2,400 feet through

the slide has been widened from 300 to 500 feet. The slope of the material in motion varies from one vertical to four horizontal to one vertical to six horizontal.

The old slide at Buena Vista, station 1559 to 1567 west, showed signs of new life in December, 1915, and January 1, 1916, a break had developed, starting at station 1559, running over the top of a small hill 300 feet west of the prism line at station 1563 and joining the canal again at 1567. The material involved was stiff clay and soft rock. On January 3, 1916 the hydraulic grader began operations, starting at a point about 50 feet back of the break and cutting a uniform slope from the point of beginning to the base of the slide near the water's edge. This method seems to have been effective, as the movement stopped soon after operations were started and the slide has been quiescent for the remainder of the year.

The passage of commercial shipping through the canal was suspended on account of slides August 7 to 10, 1915, September 4 to 9, 1915, September 18, 1915, to April 15, 1916.

Daily surveys were made in the vicinity of the active slides and the channel dragged and marked with buoys for the passages of ships. At times the channel shoaled so rapidly it was necessary to drag immediately before the passage of each ship.

#### DUMPS.

The spoil from Gaillard Cut was disposed of on dumps located in Gatun Lake, from Gamboa, mile 30, to San Pablo, mile 24½; in the Rio Grande Valley south of Cucaracha, Miraflores Lake, at Paraiso, and along the east bank of the canal between Cucaracha slide and Paraiso. Eleven million one hundred and twenty-six thousand six hundred and twenty-five cubic yards were dumped in Gatun Lake; 966,149 cubic yards in the Rio Grande Valley; 72,214 cubic yards in Miraflores Lake; 501,615 cubic yards in swamps around Paraiso; and 1,116,461 cubic yards in the canal between Cucaracha and Paraiso. The material dumped in the canal was from the ladder and dipper dredges working on the south side of the slide during the time the canal was blocked by Culebra slide, and has been practically all rehandled and removed from the prism.

#### SECOND DISTRICT.

Dredges removed 45,461 cubic yards of earth from the canal prism at the Atlantic entrance; 20,746 cubic yards were construction and 24,715 cubic yards maintenance excavation.

No dredging was done in the Gatun Lake section, Gatun Locks to Gamboa Bridge.

Material excavated in the second district was dumped on Mindi Island.

#### MISCELLANEOUS DREDGING.

##### PACIFIC TERMINALS.

From the Balboa Inner Harbor 906,286 cubic yards of earth and 33,554 cubic yards of rock were removed by pipe-line and ladder dredges; 33,673 cubic yards of earth and 2,800 cubic yards of rock from the slip south of Pier No. 18; 188,804 cubic yards of earth and

7,804 cubic yards of rock from the slip north of Pier No. 18; 22,119 cubic yards of earth from along Pier No. 14; 541,304 cubic yards of earth and 3,000 cubic yards of rock from the harbor basin proper; 81,005 cubic yards of earth and 19,950 cubic yards of rock from the cofferdam across the dry-dock entrance; and 39,381 cubic yards of earth from along the coal reloader wharf. Soft material beneath Pier No. 18 and the coal reloader wharf was sluiced out by dredge No. 85 and the hydraulic grader No. 1. Material removed by pipe-line dredges was used in reclaiming the swamp lands north of Balboa and in the San Miguel section of Panama City; that removed by ladder dredges was towed to sea and dumped, except 4,080 cubic yards dumped around the new oil crib and 1,400 cubic yards placed in storage for a future use in filling beneath the oil crib.

#### ATLANTIC TERMINALS.

From the Atlantic terminals 318,355 cubic yards of earth and 550,257 cubic yards of rock were removed by pipe-line and ladder dredges; 23,117 cubic yards of earth and 45,069 cubic yards of rock from the approach channel, opposite Piers No. 10 and No. 11; 1,380 cubic yards of earth and 2,708 cubic yards of rock from the old coal slip; 26,597 cubic yards of earth for the oil and water crossing and 22,100 cubic yards of earth from the cable crossing in Cristobal Harbor; 24,832 cubic yards of earth and 1,200 cubic yards of rock from the slip between Piers No. 7 and No. 8; 112,847 cubic yards of earth and 147,607 cubic yards of rock from the east channel, 41,909 cubic yards of earth and 259,410 cubic yards of rock from the west channel; 34,232 cubic yards of earth and 92,917 cubic yards of rock from the turning basin; and 31,341 cubic yards of earth and 1,346 cubic yards of rock from the submerged storage basin, at the Cristobal coaling station.

Material removed by pipe-line dredges was used—47,181 cubic yards in fill under docks at the coaling station; 431,065 cubic yards in the coal storage area; 12,493 cubic yards in fill around the substation fill; 24,665 cubic yards in the Camp Bierd fill; 19,851 cubic yards in sanitary fill west of the coaling station; 112,711 cubic yards reclaiming swamp land east of Dock No. 13; 4,088 cubic yards of earth in the swamp south of the dry dock. The material removed by ladder dredges was used; 190,526 cubic yards on the east breakwater and 26,032 cubic yards on the Cristobal mole.

#### FORTIFICATION RESERVE.

On the fortification reserve at Toro Point, 43,468 cubic yards of sand was placed in fills by pipe-line dredge.

#### EAST BREAKWATER.

Pipe-line dredges removed 353,344 cubic yards of coral sand and rock at Coco Solo for filling the core and toes of the breakwater; 148,440 cubic yards were pumped into the core and 204,904 cubic yards on the toes of the breakwater. In addition, 190,526 cubic yards of material from the approach channel and coaling station were dumped from scows, along the toes.



The discharge pipe line was run down the center of the breakwater trestle, suspended beneath the cap timbers with U-shaped hangers, and discharged overboard. The toe fills were made by suspending from 20 to 45 feet of discharge pipe as required, from a boom mounted on a flat car and connecting up with the main discharge line from the dredge. As the filling progressed, the car was moved forward and a new length added to the discharge line. The greatest length of discharge line was 12,509 feet, with two relays; one 4,200 feet and the other 8,400 feet from the dredge.

#### SAND AND GRAVEL PRODUCTION.

The sand and gravel necessary for construction purposes was excavated by pipe-line and ladder dredges from the gravel beds in the overflow section of the Chagres River, above Gamboa.

There were excavated by ladder dredge No. 1 and delivered to the Gamboa handling plant, 463,377 cubic yards of run-of-bank gravel. Suction dredge No. 82 excavated only material to be screened, and delivered 48,895 cubic yards of sand, 17,277 cubic yards of No. 1 gravel, to the Gamboa handling plant, also 50,851 cubic yards of No. 2 gravel.

The sand was passed through a three-eighth inch screen; No. 1 gravel over a 2-inch screen and No. 2 gravel through a 2-inch screen.

#### DIVERSIONS AND DRAINAGE.

The diversion ditches diverting the water of the Obispo diversion into the canal were cleared of grass and small slides removed.

Ditches were excavated at Culebra slide east, Culebra slide west, and at Cucaracha by the hydraulic graders, to provide a quick run-off for the storm and surface waters, and prevent ponds from forming in the low areas and depressions. Over 7,500 linear feet of ditch were excavated and maintained.

A concrete spillway was constructed to carry the water of the Rio Grande into the canal.

The gang engaged in digging drainage ditches through the hydraulic fills on the reclaimed swamp lands at San Miguel and north of Balboa, completed the work in July, 1915.

#### SLIDE INSPECTION AND REPORTS.

Inspection of all active slides were made from time to time; new breaks located and reported. A number of points were established on the east and west Culebra slides, their horizontal and vertical movements checked from day to day, and reported to the office of the engineer of maintenance.

At the request of the chairman of the slide commission, December, 1915, to January, 1916, perforated pipes were driven on 300-foot centers, over the sliding areas, and weekly readings taken to determine the elevation of the ground water.

Characteristic samples of the material in Cucaracha and the Culebra slides were taken, packed, and shipped to Washington for analysis.

Areas draining into the west Culebra slide were tiled and the storm and surface water diverted away from the slide.

## MINDI DIKES AND GROINS.

The three rock dikes, A, B, and C, built on the south shore of Limon Bay in 1915, located 600, 1,100, and 1,600 feet west of the canal prism, were repaired when damaged by the heavy seas during the dry season. The dikes were built to prevent the further erosion of the beach at this point and have proved entirely successful. This beach receded, during the period 1905-1911, 525 feet, or about 88 feet annually. Most of this erosion occurred between June, 1907, when dredging operations were started, and June, 1911, which would be at the rate of 130 feet a year for the period. July, 1911, to June, 1912, the beach receded 75 feet; 1912-13, 110 feet; 1913-14, 48 feet; 1914-15, 40 feet; 1915-16, since the dikes were completed, there has been no change. In addition the minus contours have moved out from 25 to 100 feet, showing the beach to be assuming a more regular slope. There has been but a few thousand yards of silt deposited in the canal opposite this point, during the year, where in past years the silting of the channel has run into the hundred thousands.

The wooden groins built in 1915 at intervals of 400 feet from Dike C to Kinneys Bluff, have been repaired and maintained throughout the year and new sections added from time to time as needed. From July to January the beach continued to show a slight scour; February to March showed no change; April to June showed a decided filling along practically the entire beach. On June 30, 1916, the zero contour, mean sea level, showed a gain over 1915, for the greater part of the beach. The beach between groins No. 2 and No. 3, No. 3 and No. 4, showed a decided tendency to scour. Two new groins No. 2½ and No. 3½ were built, one between groins No. 2 and No. 3, and the other between groins No. 3 and No. 4, which stopped the scouring and the beach is now building up again.

It is recommended that the groins be maintained until the end of the next dry season, by which time the east breakwater will have been completed and the groins can be abandoned or replaced with permanent ones, as the then existing conditions warrant.

## WATER HYACINTHS.

The destruction of water hyacinths in the canal, Gatun Lake and its tributaries, was continued throughout the year. The outfit used and methods employed, were the same as in previous years, except that in the case of young plants it was found to be more effective to abandon spraying and pull the plants. Young plants are more or less scattered and the arsenic solution used is washed off by the waves and rains.

Two hundred and seventy-one thousand nine hundred and fifty square yards were killed by arsenic spraying and 478,200 young plants pulled up and deposited on shore. The only old plants found during the year were in the Mandingo River and a small bed in the upper Chagres, 7 miles above Gamboa. All of the spraying done was in the overflow section of the Obispo River, where the water lettuce had grown so as to hide the young hyacinths, and the whole mass had to be sprayed and killed.

An inspection of the waters of Gatun Lake, including the upper Chagres Valley as far as the mouth of the Pequeni River, the Trini-

dad, Siri, Gatun, Chilibre, Cano, Gatuncillo, Gigante, Mandingo, and Obispo Rivers was made. No hyacinths were found in the lake north of Bohio, although the upper Trinidad and Gatun River Valleys are so badly choked with drift and floating islands that a complete inspection was impossible.

#### SURVEYS.

The usual surveys were made of the dredged areas in the canal prism, Cristobal Harbor, Toro Point, Coco Solo, Limon Bay, and Balboa Inner Harbor; cross sections plotted, reports and estimates prepared. The general progress surveys were made every four months.

Daily progress surveys were made at Culebra slide, stations 1770 to 1798, the channel dragged and buoyed before the passing of ships.

Topographic surveys were made of the Cucaracha and Culebra slides and maps prepared. Special surveys were made to determine the movements of the active slides.

At the request of the chairman of the slide commission, points were established on Gold, Zion, Contractors, and Purple Hills, also at the base of Gold and Contractors Hills, their positions and elevations accurately determined, which are checked from time to time to determine any movement or indication of sliding.

#### OFFICE.

Routine clerical work, preparation of progress records, estimates, requisitions, etc., was satisfactorily performed during the year.

Respectfully submitted.

W. G. COMBER,  
*Resident Engineer.*

Maj. Gen. GEO. W. GOETHALS, United States Army,  
*Governor, The Panama Canal, Balboa Heights, Canal Zone.*



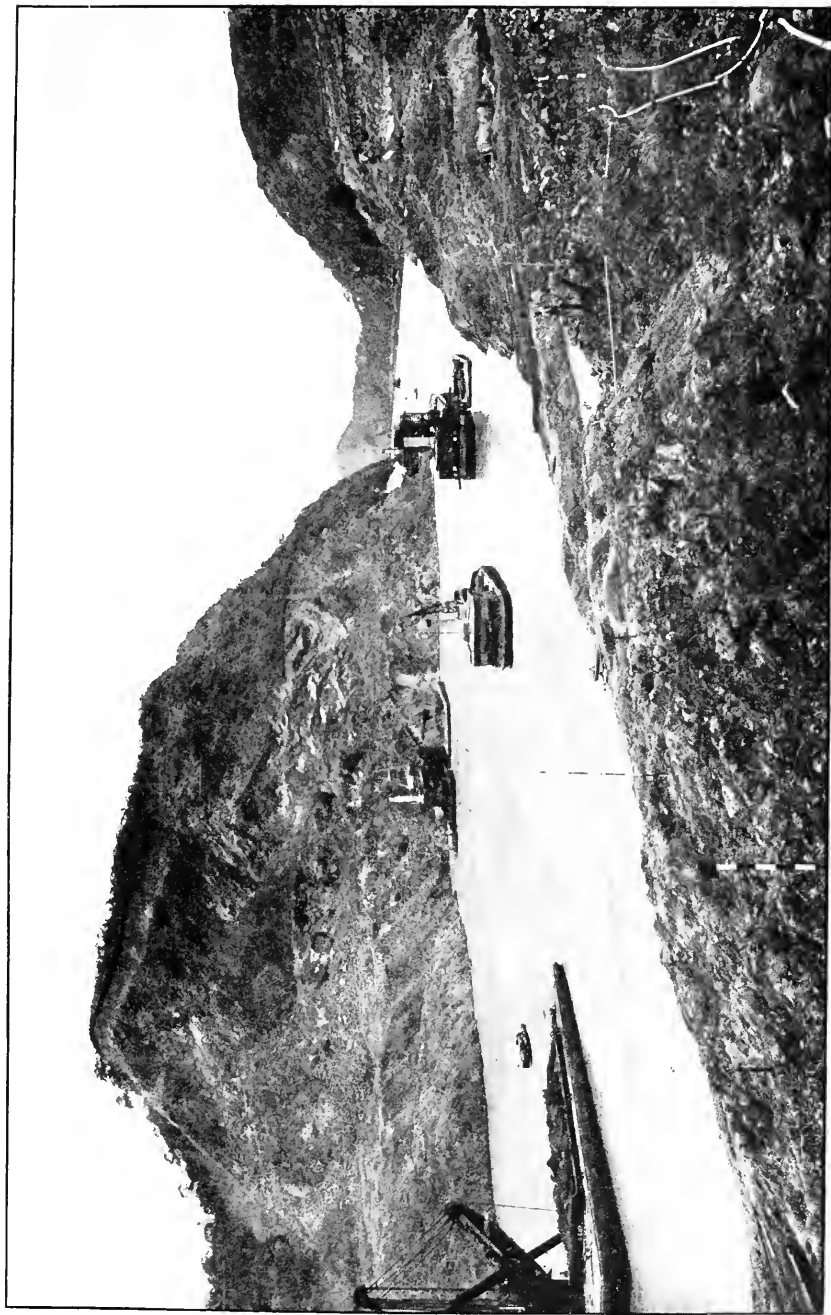
TABLE No. 12.—*Dredge excavation.*

TOTAL QUANTITIES AND COSTS OF ALL MATERIAL REMOVED FROM THE PANAMA CANAL AND AUXILIARY WORKS BY DREDGING.

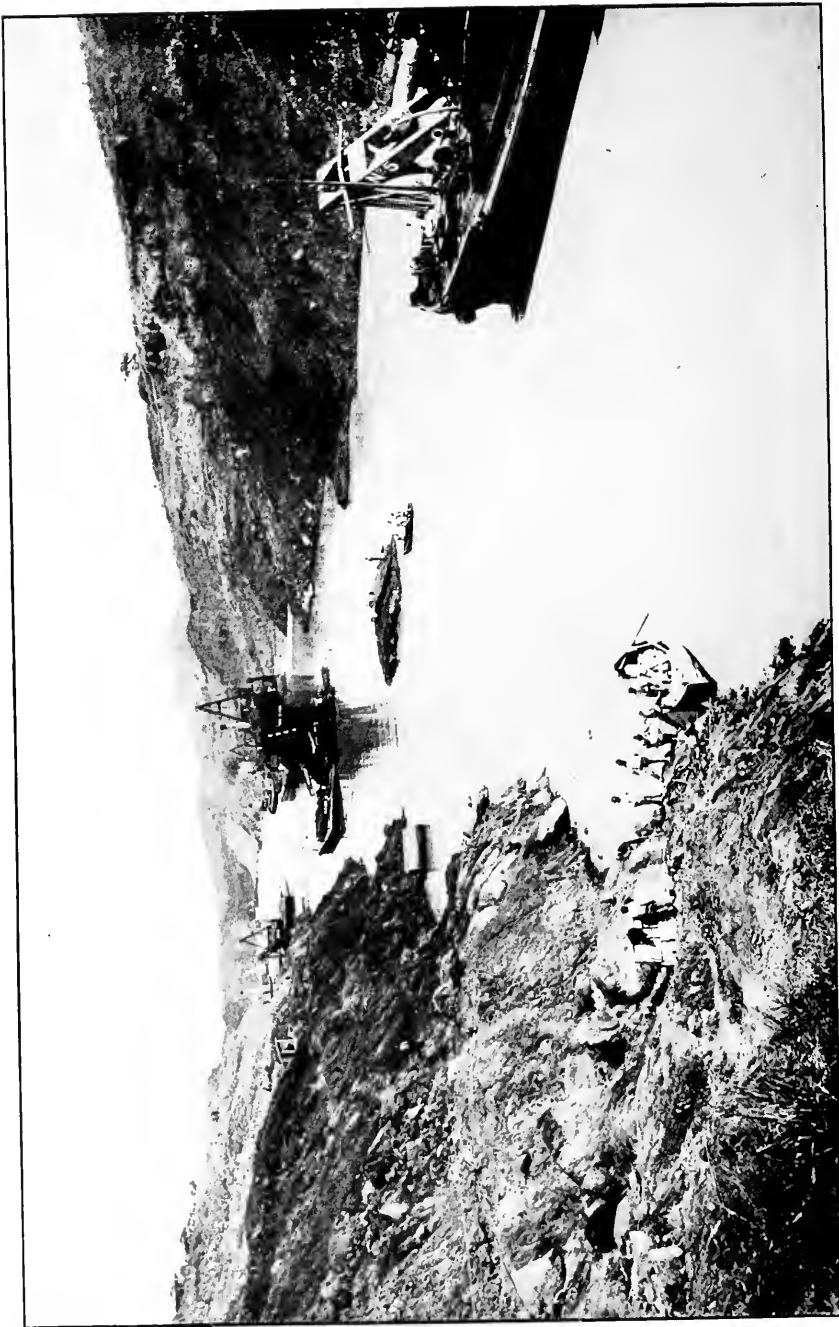
Fiscal Year.	Canal prism.				Other than canal prism.				Grand total of dredge excavation.			
	Earth.	Rock.	Total.	Cost.	Unit cost.	Earth.	Rock.	Total.	Cost.	Unit cost.	Cost.	Unit cost.
1905.	111,376	.....	111,376	\$23,042.58	\$0.2069	.....	.....	.....	.....	.....	.....	.....
1906.	1,832,959	83,500	1,916,459	398,018.77	.2077	1,832,959	83,500	1,916,459	\$23,042.58	\$0.2069	398,018.77	.2077
1907.	2,306,611	43,602	2,350,213	487,832.08	.2076	2,306,611	43,602	2,350,213	487,832.08	.2076	487,832.08	.2076
1908.	10,348,575	12,417	10,360,992	2,142,387.40	.2068	10,348,575	12,417	10,360,992	2,142,387.40	.2068	2,142,387.40	.2068
1909.	14,211,569	417,621	14,629,190	3,037,231.38	.2076	16,724,752	445,510	17,170,262	3,502,005.55	.2040	3,502,005.55	.2040
1910.	11,443,462	369,121	11,812,583	2,820,361.98	.2388	15,905,725	548,573	16,454,298	5,264,821.26	.2839	5,264,821.26	.2839
1911.	10,589,837	788,150	11,377,987	2,638,344.38	.2364	17,730,409	811,889	18,542,298	4,461,621.96	.2712	4,461,621.96	.2712
1912.	7,774,637	980,477	8,755,114	1,946,231.51	.2253	12,791,418	1,064,125	13,855,543	4,229,321.85	.3052	4,229,321.85	.3052
1913.	7,004,415	1,800,949	8,805,364	2,756,245.36	.2551	11,318,391	1,990,233	13,308,624	3,701,560.40	.2781	3,701,560.40	.2781
1914.	7,165,472	3,863,169	11,028,641	3,381,927.96	.3066	4,146,175	4,146,175	8,292,350	4,570,234.36	.2839	4,570,234.36	.2839
1915.	2,520,346	5,786,916	8,307,262	2,814,413.96	.3388	8,019,585	6,271,573	14,291,158	4,067,823.08	.2839	4,067,823.08	.2839
1916.	3,040,884	111,001,263	114,042,147	3,789,477.10	.2699	5,019,585	11,808,226	16,827,811	4,363,443.38	.2593	4,363,443.38	.2593
Total.	80,350,143	25,147,485	105,497,628	26,286,734.46	.2492	31,953,186	2,078,338	34,031,524	10,925,378.19	.3210	37,212,112.65	.2667

<sup>1</sup> Also maintenance excavation.<sup>2</sup> Includes 1,124,282 cubic yards rehandled in the canal prism.  
Includes excavation for locks, dams, terminals, harbors, sand and gravel service, and all other auxiliary excavation.





GAILLARD CUT. LOOKING SOUTH FROM WEST BANK. DREDGES WIDENING CHANNEL TO 500 FEET. JULY 14, 1916.



GAILLARD CUT. CULEBRA SLIDE OF SEPTEMBER 18-19. LOOKING NORTH, SHOWING FRENCH DREDGES "No. 5" AND "MARMOT" MAKING OPENING CUT. SEPTEMBER 21, 1915.

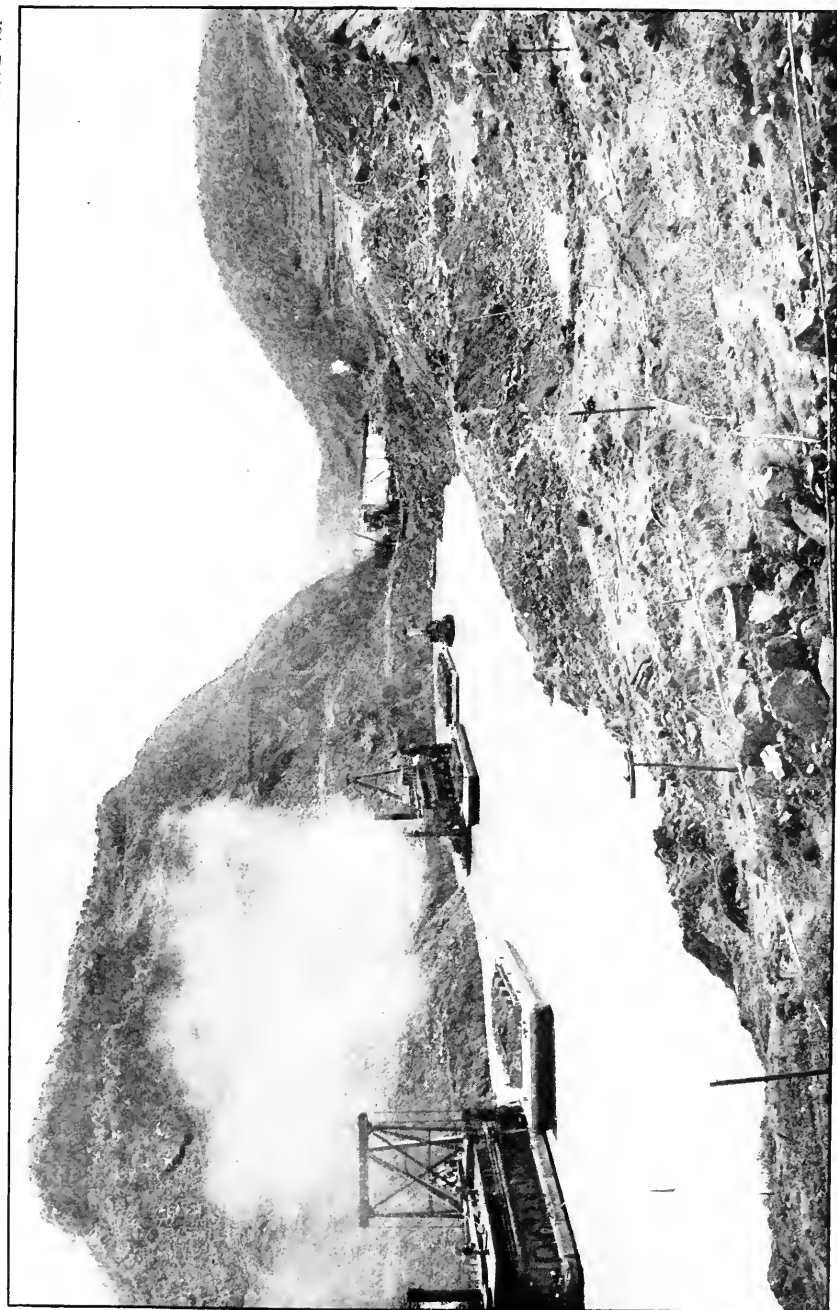




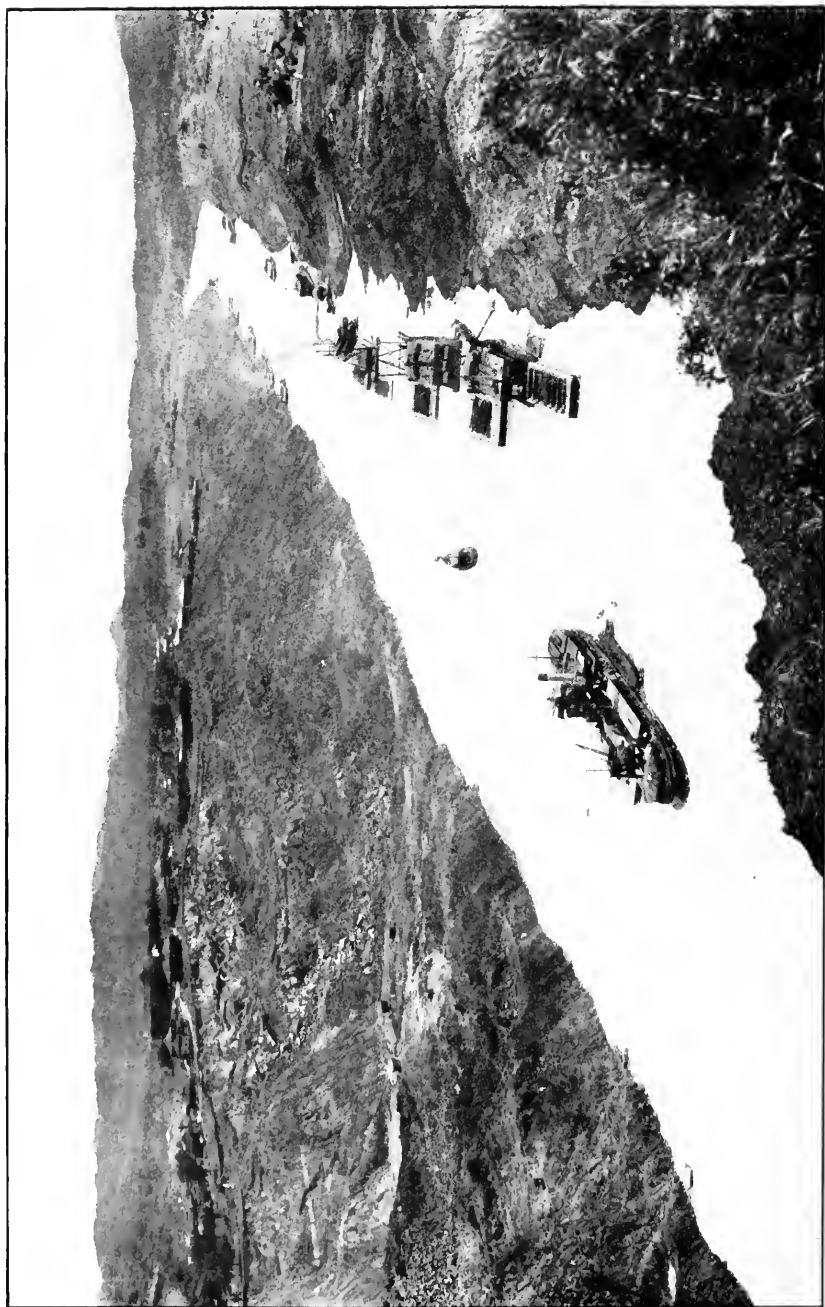
GAILLARD CUT. CULEBRA SLIDES. BARRIER FORMED BY SLIDES ACROSS CHANNEL, LOOKING EAST FROM WEST BANK, OCTOBER 30, 1915.



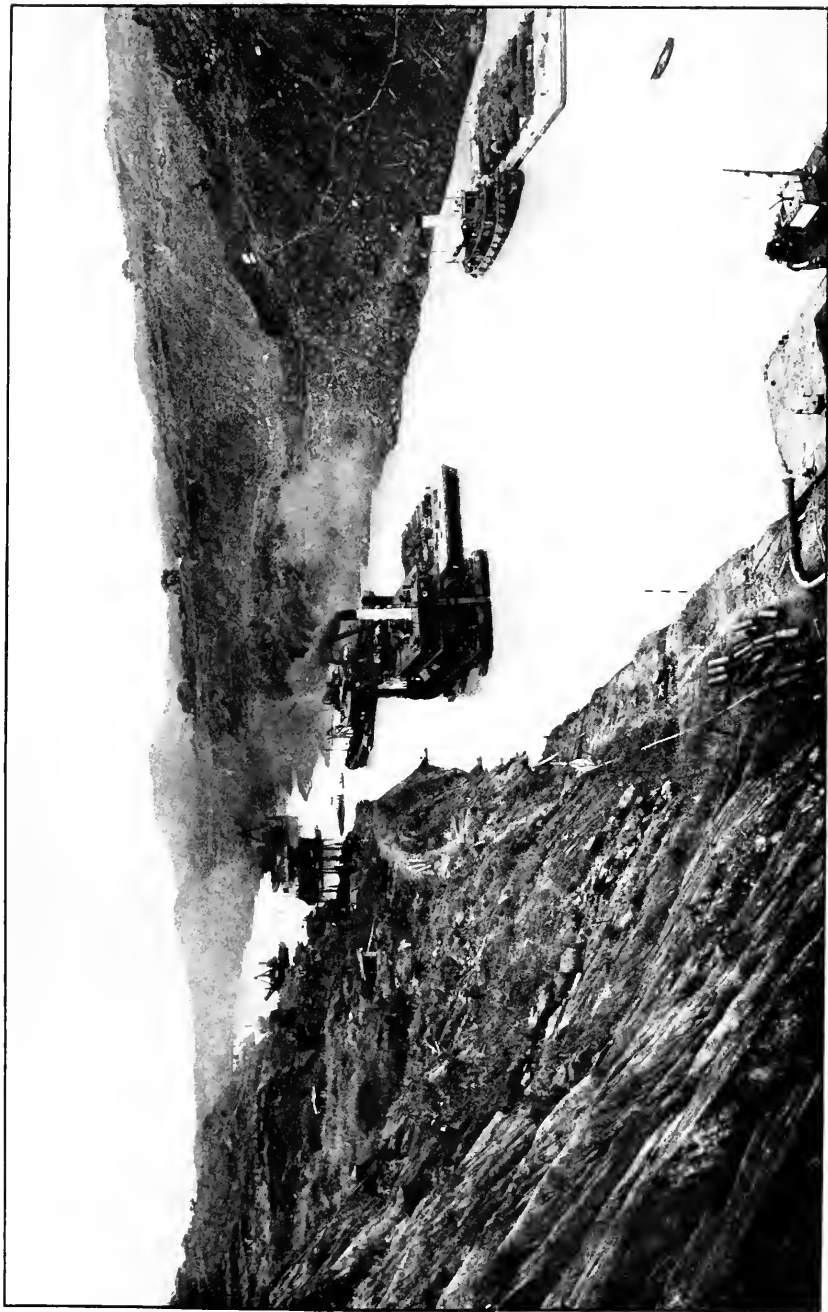
GAILLARD CUT, CULEBRA SLIDE IN EAST BANK NORTH OF GOLD HILL, LOOKING TOWARD WEST BANK, SHOWING LARGE  
MASSES OF BROKEN MATERIAL. OCTOBER 23, 1915.



GAILLARD CUT, CULEBRA. LOOKING SOUTH FROM WEST BANK. CHANNEL COMPLETELY BLOCKED BY SLIDES FROM EAST AND WEST BANKS. DREDGES EXCAVATING SLIDE MATERIAL. NOVEMBER 18, 1915.



GAILLARD CUT. LOOKING NORTH FROM TOP OF GOLD HILL, SHOWING CUT 500 FEET WIDE. JULY 14, 1916.

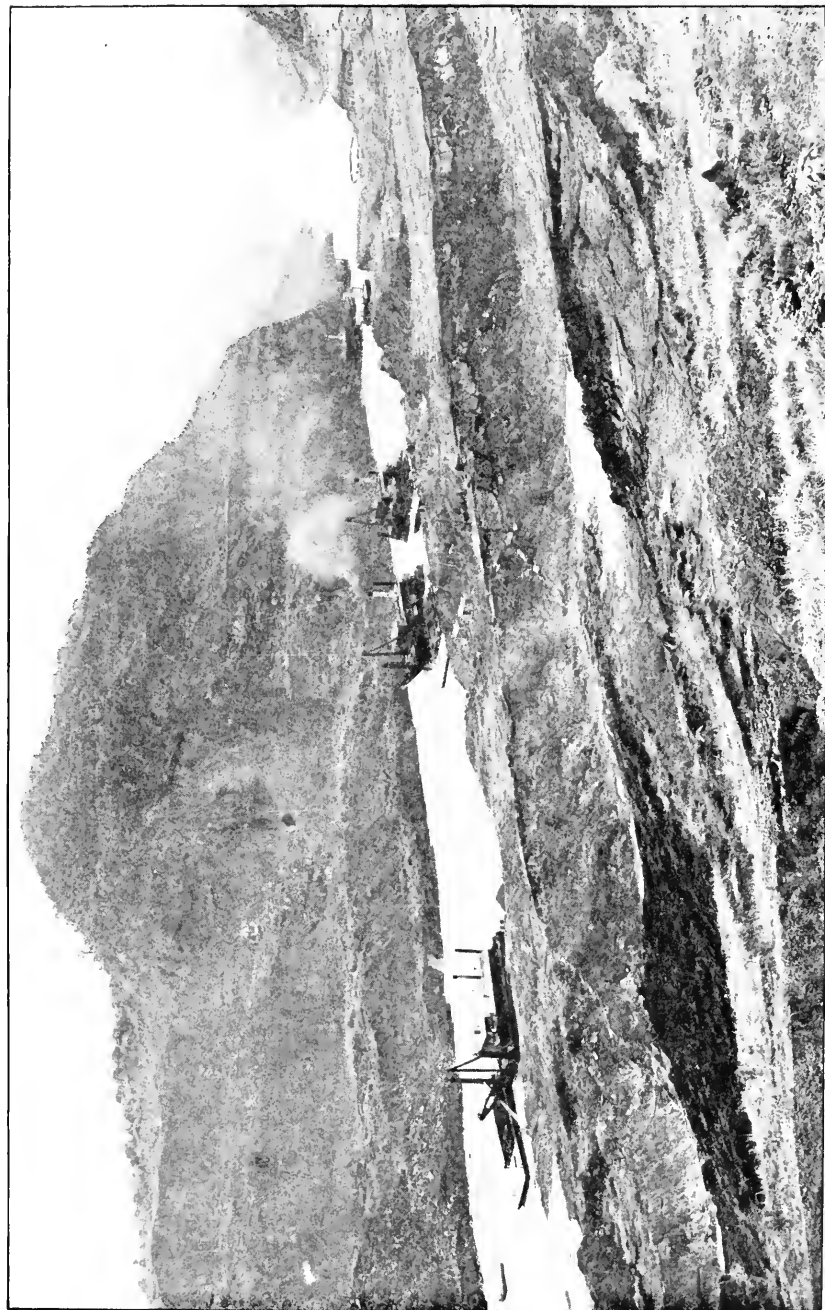


GAILLARD CUT. CULEBRA SLIDE OF SEPTEMBER 18-19. LOOKING NORTH FROM CONTRACTORS HILL. FRENCH DREDGES "NO. 5" AND "MARMOT" MAKING OPENING (FIRST) CUT THROUGH SLIDE. SEPTEMBER 21, 1915.

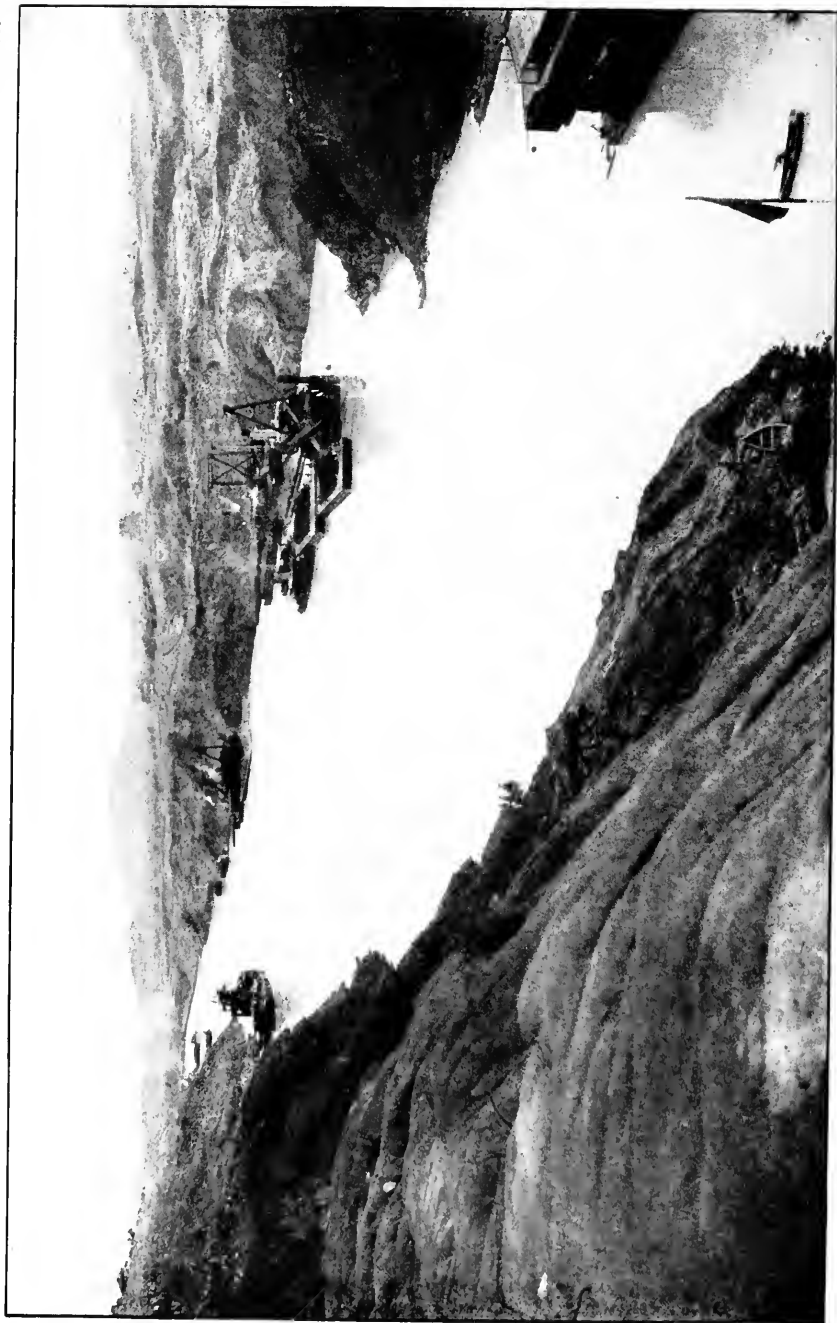


GAILLARD CUT. LOOKING NORTH FROM CONTRACTORS HILL, SHOWING PROGRESS OF WIDENING CHANNEL THROUGH THE CULEBRA SLIDES.





GAILLARD CUT. CULEBRA SLIDE, WEST. DREDGES REMOVING THE SLIDE FROM CANAL PRISM. LOOKING SOUTH FROM CULEBRA. AUGUST 8, 1915.

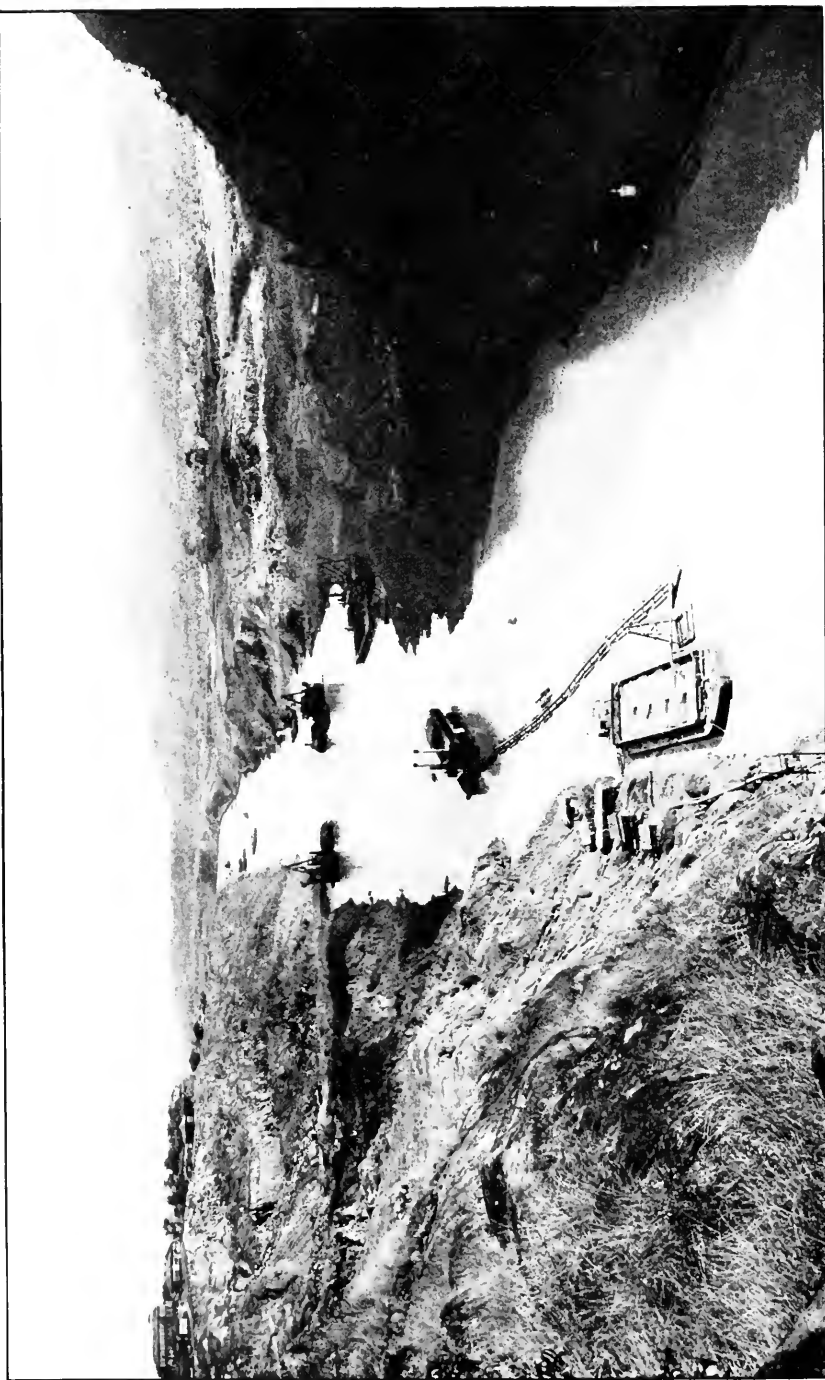


GAILLARD CUT. LOOKING NORTH FROM WEST BANK. JULY 14, 1916.

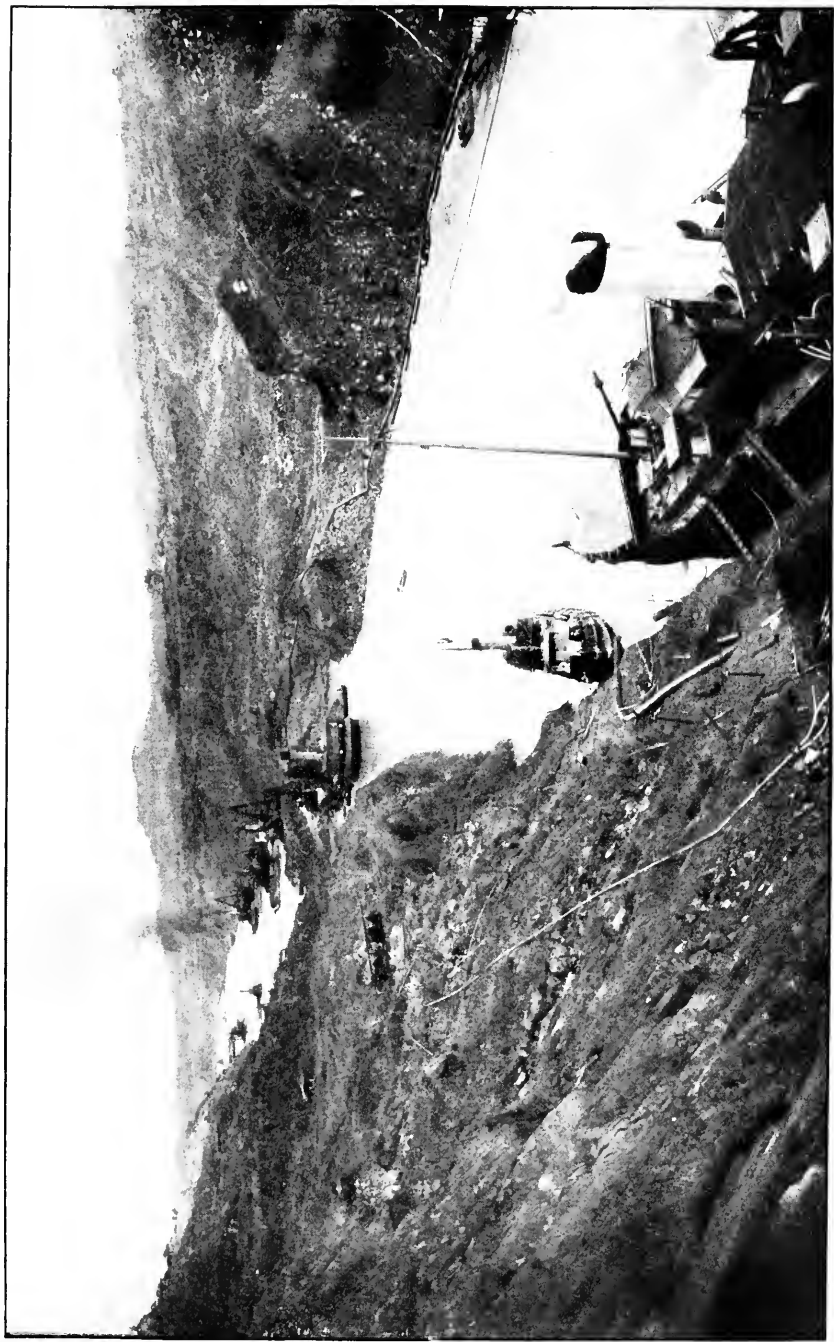




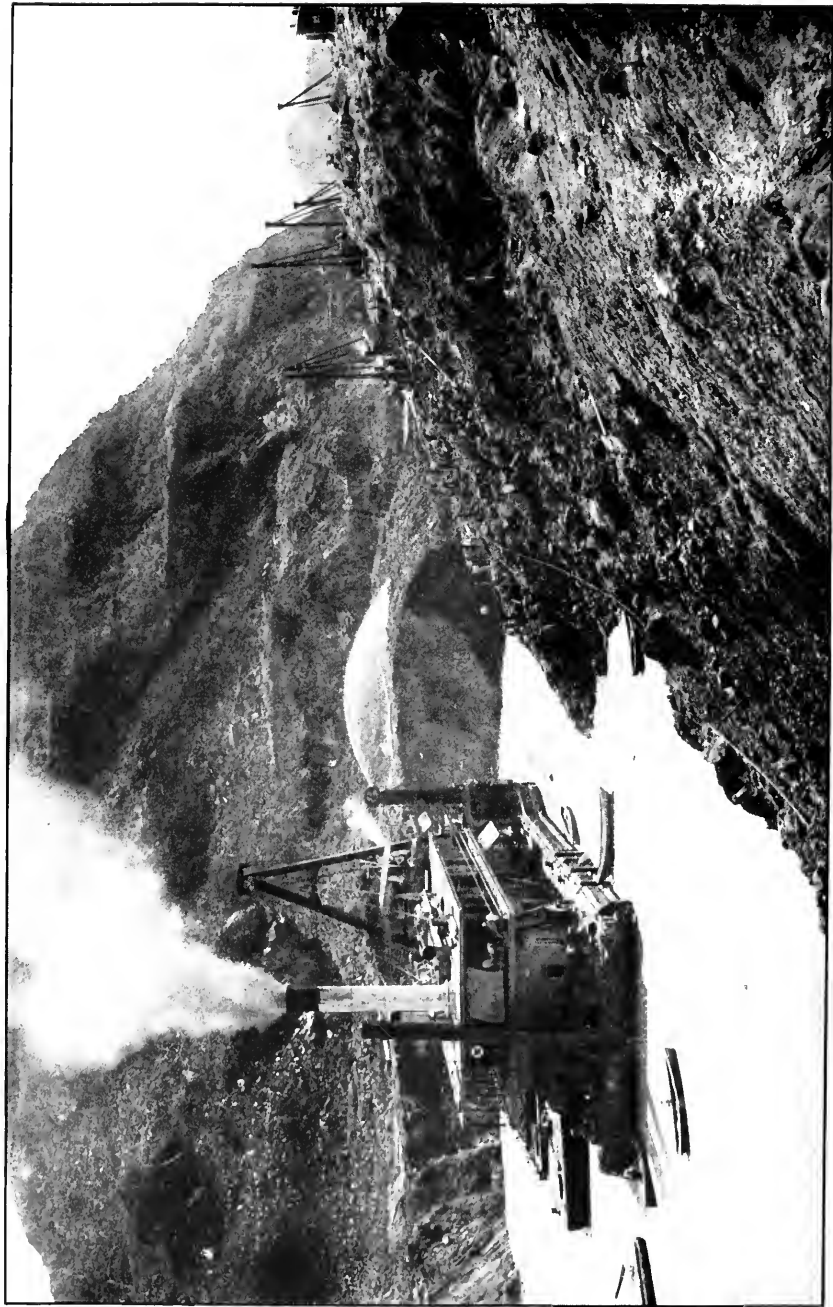
GAILLARD CUT, CULEBRA. LOOKING NORTH FROM CONTRACTORS HILL. DREDGES REMOVING SLIDE MATERIAL FROM CANAL PRISM; CHANNEL PRACTICALLY CLOSED BY MEETING OF SLIDES FROM THE BANKS. OCTOBER 21, 1915.



GAILLARD CUT. SLIDES IN WEST AND EAST BANKS. LOOKING NORTH FROM CONTRACTORS HILL, SHOWING DREDGES WIDENING CHANNEL FROM 300 TO 500 FEET; 3,000 YARD BARGE BEING LOADED FROM SUCTION DREDGE. JULY 3, 1916.



GAILLARD CUT, CULEBRA. LOOKING NORTH FROM CONTRACTORS HILL, SHOWING BARRIER ACROSS CANAL FORMED BY SLIDES FROM EAST AND WEST BANKS. NOVEMBER 18, 1915.



GAILLARD CUT, CULEBRA. NORTH SIDE OF SLIDE BARRIER ACROSS CANAL, SHOWING 15-YARD DIPPER AT WORK.  
NOVEMBER 16, 1915.



SOUTH SHORE OF LIMON BAY. LOOKING WEST FROM CANAL, SHOWING DIKES AND GROINS. JUNE, 1916.



## APPENDIX F.

### REPORT OF THE SUPERINTENDENT, MECHANICAL DIVISION.

BALBOA, CANAL ZONE, *July 29, 1916.*

Sir: In compliance with instructions contained in your circular letter of June 13, I have the honor to submit the following report relative to the operations of the mechanical division for the fiscal year ended June 30, 1916.

#### ORGANIZATION.

The general organization of the division was the same as for the previous fiscal year. The superintendent, assistant superintendent, mechanical engineer, chief clerk, traveling engineer, chief draftsman, and certain subordinates in clerical and drafting positions were considered as on general duty in the division with headquarters in building No. 28, Balboa shops. Other employees were attached to individual plants, but were subject to transfer from one plant to another by the superintendent as best fitted the exigencies of the service. The organization of the division as a whole was prepared, without regard to employees of individual plants, although for use within the division each plant is provided with its own organization. This arrangement gives the greatest flexibility possible and permits the minimum number of excess positions in the division organization to allow for temporary fluctuations of force at the individual plants.

In addition to their general duties, the assistant superintendent has had special charge of the Balboa shops, and the mechanical engineer of the plant and construction work and special investigations for plants. In general the local organization of the various plants has remained unchanged. The machine department at Balboa has continued under the charge of Mr. S. G. Shearer, general foreman, assisted by Assistant General Foreman C. S. Perry. It is proposed to employ an assistant general foreman in charge of the combined shipfitter and boiler shop, and steps are now being taken to obtain an employee of suitable experience and capacity. The car shop and wood-working shops have remained under the immediate supervision of General Foreman A. O. Herman. The dry dock shops at Cristobal have remained under the supervision of General Foreman C. J. Reilly, and Mr. James Macfarlane, superintendent of dredging, assistant to the resident engineer of the dredging division, has continued to exercise supervision over the Paraiso shops, answering in this capacity to the superintendent of the mechanical division. With the opening of the dry docks at Balboa, a dockmaster and a foreman rigger, competent and experienced in the handling of ship's lines and heavy weights on ships have been employed, as noted elsewhere. The Balboa roundhouse has continued under the supervision of Mr. R. A. Compton, and the Cristobal roundhouse under Mr. J. M. Abston.

## GENERAL.

At the end of the fiscal year, the plants of the division included the Balboa shops, with car shop and roundhouse, Paraiso shops, Dry dock shops, Cristobal; Cristobal roundhouse; car-inspection forces at Balboa and Mount Hope, and repair track forces within the railroad yards at Balboa and Mount Hope.

The general character of the operations tended more and more toward marine work. However, the closing down of the canal for several months and the lack of adequate storage capacity at the canal terminals resulted in work on railroad equipment being much in excess of that anticipated. Work on steam shovels and other land excavating equipment was so reduced by the cessation of quarrying operations at Sosa Hill as to permit the discontinuance of the separate gang for maintaining this equipment.

The amount of work on dredging equipment and vessels using the canal was sufficient to permit organizing the forces at Paraiso and the dry-dock shops, Cristobal, on a purely marine basis. The marine work at Balboa increased materially and a larger percentage of the employees were required to have marine experience. Attainment of the ultimate operating condition has, however, been delayed by conditions in the Cut.

When my estimates were made for the fiscal year 1916, none were included for the force employed at the Paraiso shops, as it was expected that they would be closed not later than January 1, 1915. As it turned out, these shops actually performed more work during the fiscal year referred to than during any other since they were established. The prospects now are that the volume of this work will decrease, but it seems unlikely that the shops may be closed for at least another year.

The completion of Dock No. 18, at Balboa, and Pier No. 7, at Cristobal, will increase the terminal storage capacities and will permit reduction in railroad equipment, unless transportation of large quantities of freight across the Isthmus by rail should be made necessary through the closing of the canal. However, the conditions of use of railroad equipment are so uncertain that it will probably not be wise to retire any great percentage of this equipment for some time to come.

The office building, building No. 28, at the Balboa shops, is the headquarters of the general supervisory force of the division, and all experimental work and special drafting is done there. For this force the portion of the building assigned to this division proved insufficient and it was necessary to crowd some of the forces undesirably. No space could be found for the apprentice school, except in the public school buildings and this interfered considerably with the school division's work. With the removal of the forces of the captain of the port and customs office from the second floor to the new terminal office building at Dock No. 17, room for the apprentice school will be found; also room for expansion of the office forces of the mechanical division and the general storekeeper, the latter of which have occupied a restricted space on the second floor. The intimate relations of the mechanical division and the general store make it desirable to have the office forces of the two establishments housed in the same building and this arrangement will be continued.



The apprenticeship system, proposed in my letter of June 8, 1914, and authorized, with slight modifications, by the Governor on March 11, 1915, has now been in effect for 16 months. Thirty-two apprentices have been taken on, and in collaboration with the superintendent of schools the system of instruction has been worked out and has been in use for one full year. Instruction in all subjects except drafting and the calculations connected therewith has been given by the supervisor of industrial training, detailed by the superintendent of schools. Drafting and the calculations incident thereto have been taught by draftsmen detailed from this division. The course contemplates two 2-hour periods per week for each apprentice in general studies and a similar number of similar periods in drafting. The mental advancement of the boys at time of employment has varied widely. Many of the candidates for employment, either from carelessness or interruption in their school work, have come to an age such that they feel embarrassed when attending school in the grade in which their advancement in their studies properly places them. Some of the applicants have not advanced sufficiently in school work to satisfactorily learn a trade under modern conditions. Others have quit school on account of unsatisfactory conduct. The number of applications has been so much in excess of the number of apprentices that could be efficiently cared for that the definite policy has been adopted of not accepting any boy for appointment unless he has reached at least the sixth grade in school and unless he presents evidence that his conduct at school has been satisfactory. This has had, I think, a salutary effect upon the conduct and application of many boys at school and has proven a desirable rule from the standpoint of both this division and the division of schools. A suitable form for certificate of completion of apprenticeship has been approved by the Governor and certificates have been issued to three ex-apprentices during the year.

#### DRY DOCKS AND SHOPS.

Delays in receipt of material prevented the anticipated progress toward completion of Dry Dock No. 1, at Balboa, thus delaying the actual completion of work on the Balboa plant. All authorized work, not held up by the dock, had been practically completed by the end of the fiscal year except a small amount of filling and grading, erection of two bents of Pier No. 12, repairs to roofs and buildings made necessary by blasting at Sosa Hill, and a small amount of other miscellaneous work.

At the end of the fiscal year the capstans and traveling crane for Dry Dock No. 1 had not been delivered and the official test of the dock pumps had not been begun. It was possible, however, on June 28, to dock the seagoing ladder dredge *Corozal*, and to remove the water from the dock with the main pumps. They gave very satisfactory service, and there was no reason to anticipate delay in the completion of the tests. Unrestricted use of the dock will be prevented until probably the middle of September, due to the necessity for fitting a finishing service of concrete over the whole area of the floor. It is proposed, however, to occupy the dock with dredging equipment too large to be handled in the dry dock at Cristobal, and to proceed with the finishing work on the floor and blocks as circum-

stances permit. In the meantime the cofferdam is being rapidly removed, and by August 15 it is expected that vessels of 70-foot beam and 24-foot draft may be taken through the opening at high tide. The capstans will require comparatively little work for their installation, and after they are installed the only equipment remaining will be the 50-ton traveling crane, delivery of which is not due until November 11, 1916. Its design is similar to that of cranes used for like purposes at navy yards.

A considerable amount of work has been done by this division in assembling the dock equipment and portable appliances. The dock, when completed, will be without a superior anywhere. The pumps will be able to remove the water in less than two hours at any stage of the tide, and by actual test the dock was completely flooded in 16 minutes at high tide.

The organization for the operation of the dock was inaugurated by the employment of Mr. Alexander Grieg, on June 15, 1916, as foreman shipwright and dockmaster. Mr. Grieg was for two years in charge of the naval floating dry dock *Dewey* at Olongapo, P. I., and has been connected with the operation of dry docks for many years. His services promise to be most satisfactory and have already proven of value in checking up final details and looking after items of equipment and fittings.

Anticipating the necessity for establishing rates for the commercial use of Panama Canal dry docks, data as to rates have been obtained from various docks in North and South America. So far this has not been worked up sufficiently to permit recommending rates, but it will be done shortly, as there have already been a number of applications for docking. Most of these have been for vessels which might be accommodated in the dock at Cristobal. In all probability the Balboa dock will not be regularly available for commercial use for some time, because it will have to be used for making extensive repairs and alterations to dredging equipment too large to enter the Cristobal dock. It is hardly to be expected, therefore, that the docking situation will reach a normal condition until some time next year.

For repairs to dredging equipment and for most of the commercial docking Dry Dock No. 2 (completion of which has been abandoned for the present) would be more efficient than Dry Dock No. 1, on account of the large size and great depth of the latter, which increases the cost of pumping and of handling material and men. The location of the coaling plant alongside the entrance slip to the dock will interfere to some extent with access to the dock. The amount of this interference will probably not be great because only the vessels being unloaded will ordinarily lie in the dock slip and the process of unloading will be rapid. Had the entrance to Dry Dock No. 2 been completed and the caisson constructed before the cofferdam was removed the dock could be used to a limited extent, if necessary. Also it could then be completed without rebuilding the cofferdam, thus effecting a saving in ultimate cost. It might also have been used for the construction of barges, etc., some work of which character seems likely to be necessary in order to maintain a uniform force of well-trained mechanics sufficient to cover contingencies reasonably to be expected to occur. At the present rates of wages in the States I

believe new construction work could be carried on at a cost which would be within permissible limits.

One difficulty with the Balboa shops in this connection is the fact that no suitable location exists for building slips, and when the quay walls are completed as originally contemplated there will be no readily accessible place from which a vessel could be launched. At present, for small craft, building slips can be installed on that portion of the cofferdam which will remain intact abreast Dry Dock No. 2, but the location is less desirable than could be wished.

Experience at the Balboa shops early demonstrated the fact that under ordinary conditions docks Nos. 15 and 16, originally intended to be assigned for use as repair wharves, were not needed for the purpose, and they have accordingly been diverted to commercial use by the Panama Railroad. Their location abreast the offices and shops interferes considerably with mechanical-division operations, but with the completion of Pier No. 18, it will be possible to decrease this interference, and if a condition of war should result that a fleet were based on Balboa, this waterfront space closely adjacent to the shops would be invaluable for repair purposes, as by its use alone could repairs to the fleet be carried out promptly and efficiently.

Another respect in which the shops have proven inadequate is in the space and equipment for marine work. Building No. 4, now used as a combined boiler and shipfitting shop, is barely sufficient to house the needed machine tools, and it will be necessary to provide additional space for assembling work. I think this may best be done by vacating building No. 3, now used as a steel warehouse, and by roofing over the space north of the tunnel track between this building and building No. 4, and using this space and the north half of building No. 3 for assembling work and for handling material. This will be considered in connection with the submission of estimates for the next year.

The accommodations for the pipefitting and sheet-metal shop are also inadequate, and the shop occupied space needed for the smithery. Probably the best means of providing more space will be to fit up the south end of building No. 3 for this purpose and then extend the smithery to occupy all of building No. 2.

The tool-room space in building No. 1 has likewise proved inadequate and badly located. This factor was appreciated when my estimates were submitted for the current fiscal year, and an item of \$15,000 was included for providing additional space. Originally it was intended to construct a building between buildings Nos. 1 and 2, a portion to store the less frequently used machine-shop tools and the remainder for similar tools for the blacksmith shop. It has now been found preferable, however, to expend this money for the construction of an addition to building No. 1 and to devote the entire additional space to the machine-shop tool room. Storage for the blacksmith tools can be provided elsewhere.

Another building which has proven inadequate in size is building No. 9, originally intended as an instrument-repair shop and galvanizing shop. The demands for galvanizing were so small that the fittings, although manufactured, were never installed. The space constituting about 60 per cent of the total floor area was devoted to a shop for the electrical division. Both this and the space devoted

to instrument repairs and plating have proved too small. Recommendation will therefore be made that the building be widened to about twice its original width by installing new walls and extending the roof at its present pitch, this work to be paid for from the general allotment from current appropriation for plant work of the mechanical division.

Delay in the completion of building No. 29, for housing the air-compressor plant and dock pumps prevented starting the new electric-driven air-compressor plant until April of the present year and kept the old Balboa plant in service under the electrical division. Air from this plant was costly, due not only to the great length of the lines through which it was distributed, but also to the inefficiency of the compressing machinery, which had about reached the limit of its life. During the maximum operations on the Sosa Hill quarry and on dry-dock excavation this plant proved inadequate, and a 2,500-foot steam-driven compressor was installed temporarily abreast building No. 14, by which means alone could the pressure in the air mains be maintained. Three electrically-driven air-compressor units were purchased for installation in building No. 29, but in view of the delay in their installation and the run-down condition of the air compressors at Cristobal dry-dock shops, it seemed desirable to divert one of them to the last-named shops. As purchased, there were two units of 2,500 feet capacity and one of 5,000 feet capacity. It was one of the 2,500-foot machines which was installed at Cristobal. It is now found that the three machines intended for use at Balboa will probably be insufficient to supply all demands and requisition will shortly be submitted for an additional 5,000-foot unit for installation there, thus making the total capacity 12,500 cubic feet per minute, instead of 10,000 cubic feet, as originally contemplated. These compressors, together with the 550-foot electrically-driven compressor installed at the roundhouse, will give an adequate and very flexible air-compressor plant.

The provision for car-shop work at Balboa proved inadequate during the rush of railroad transportation incident to the closing of the canal in October, 1915. As was stated in my report for last year, this resulted in the necessity for opening the old car shops at Cristobal for the performance of box-car and Rodger ballast-car work. These shops were closed July 29, 1916, and the work transferred back to Balboa, where conditions had improved so it could be cared for. The car work has continued, however, to crowd the shop undesirably. By the use of repair tracks at the Balboa and Mount Hope yards, and with the completion of work on the 400 steel dump cars sold to the Chicago House Wrecking Co., in connection with closing their scrap contract, conditions promise to be fairly satisfactory.

At the beginning of the fiscal year, a number of large shop tools were under order or on requisition for the division, principally for marine work. As funds were available and needs developed, requisitions were submitted for others. There is still need for some heavy plate-working tools which will be provided from appropriations for the current year and for a number of modern tools to replace old tools which have reached the limit of their usefulness. To install all the needed equipment will involve rearrangement and reassignment of spaces in shop buildings, together with some additional building work, as outlined above. Tools already on order will be sufficient to per-

mit most of the work likely to be required on vessels to be done with fair dispatch, but deliveries under the contracts are so slow that it will be several months before they are all installed.

At Paraiso considerable increases in the machinery of the plant were made, an extension was built for the blacksmith shop, oil fuel was provided for the blacksmith shop, the tool room was extended into the space previously used as a shops' office, and the space previously used as an air-compressor plant was converted into an office for foremen. An extension was built for housing the flange fires and an additional steam hammer installed in the blacksmith shop. With the increase of work, the three 550-foot motor-driven air compressors proved inadequate to supply compressed air and one of the Babcock & Wilcox boilers formerly in use at the Gold Hill sluicing plant was erected and connected to a 2,500-foot air compressor from the old Empire air-compressor plant. The pumps for water service under the municipal engineering division were supplied with steam from the same boiler, thus permitting one force to handle both the air compressor and the pumps. This released two of the three electrically-driven air compressors, one of which was installed at the roundhouse, Cristobal, and the other at the roundhouse, Balboa, for use in connection with night work. The third will ultimately be installed at the dry-dock shops, but it is deemed desirable to retain it at Paraiso for the present, as a reserve. A fourth compressor of this type, belonging to this division, had been loaned to the division of terminal construction for use in connection with the construction of the Cristobal coal plant. A compressor of about this capacity was needed for the permanent repair plant at that place, and the necessity for a somewhat larger compressor at the Cristobal shops having been demonstrated, arrangements were made to exchange this compressor for a larger direct-connected compressor to be purchased on requisition.

At the dry-dock shops, Cristobal, very little work incident to improvement of the plant was done, with the exception of installing the new electrically-driven air compressor and electric motors for operating the dry-dock pumps. There is considerable uncertainty as to what will be the future of these shops, and consideration of modifications has been purposely deferred until more information is available. I believe that these shops will be required as a permanent institution and that the uncertainty is rather as to size than as to continuance. With all transfer of freight consolidated at the north end of the canal, it seems likely that a docking and repair business of considerable magnitude might be worked up if a dock were available which would receive ships of the type and size usual in merchant service. This will come largely from vessels sent to the canal entrance to await orders, which could use the delay to advantage by being docked and repaired. Ships bound for Pacific and Australian or Asiatic ports, discharging at Cristobal, and docked or repaired at Balboa, would either have to transit the canal twice or else would have to be docked with cargo aboard at increased expense and risk. I believe that the conditions may justify the construction of a large dock at Cristobal not only on account of the amount of work which it could do for commercial ships but also as a means of insuring facilities for repairs to the fleet, since it might easily arise that a war vessel stationed at Colon would be so badly damaged as to make it unsafe to transit the canal, or else be so urgently needed that while repairs

might be accomplished if facilities were available at that end, the time could not be spared for a trip to Balboa. The new dock, if constructed, should lie at an angle of about  $60^{\circ}$  to the present dock, extending southeast, with the entrance practically in the location now occupied by the dry-dock storehouse. This involves removing the storehouse to some other location for which the space now occupied by the Brown coal hoist and the scrap yard back of Dock No. 14 should be available and suitable. The present location of the storehouse is such that it interferes with the use of valuable water front for repair purposes, and also with the handling of material in the shops' yards on account of the arrangement of railroad tracks. In view of the above, I believe that new shop buildings should ultimately be constructed to house this plant, and the plant brought up to date in all respects. This matter, however, is not urgent, although items for commencing the work should be contained in the estimates for the fiscal year 1918.

#### MISCELLANEOUS.

The change of working hours in the Balboa shops from 7 a. m. to 4 p. m. with one hour for lunch prevented the employees of those shops (unless they lived in the immediate vicinity) from going home to lunch, and it was found necessary to establish a quick-lunch restaurant within the shops district. This was located temporarily in the wooden building constructed originally for offices of the division of terminal construction and turned over to this division in February, 1914, for use as a temporary office pending completion of building No. 28. This building is unsuitable for the purpose and constitutes a fire risk. Moreover, the ground upon which it stands is needed for other purposes. It is understood that appropriation is available for a new restaurant building, which should be located between buildings 11 and 14.

There was so much discussion relative to the alleged excessive overhead charges at the Balboa shops that it seemed desirable to make an analysis of this overhead with a view to determining whether or not it was really excessive. Indirect charges in private shops often amount to as much as 100 per cent of direct labor, and it was my belief that the overhead at Balboa (which varied from a maximum 62.06 per cent, plus machine rate, to a minimum of 45.61 per cent, plus the machine rate) was reasonable, considering the items which it included. Under the conditions, however, it seemed worth while to spend the time necessary to make an analysis upon which a comparison of the overhead at these shops might be made with the overhead of various navy yards. My familiarity with methods of work and accounting at navy yards permitted this comparison to be made accurately. I had hoped that a similar comparison might be made with the overhead at various arsenals, but upon going into the question, I found an accurate comparison impracticable because of lack of accurate knowledge of the methods of work and accounting. Comparison with the navy yards, as actually made and reported upon in my letter of September 28, 1915, was based upon operations for the month of April, 1915, at the Balboa shops and at the navy yards, Portsmouth, N. H., Brooklyn, N. Y., Norfolk, Va., Charleston, S. C., and Mare Island, Cal. These indicated that the overhead at Mare

Island was about 4 per cent less than at Balboa, but this was explainable by the very low rate for power at the navy yard. Making allowance for this item at rates obtaining at other navy yards, the overhead at Mare Island was almost identical with that at Balboa, and the variation at the other yards was small with the exception of the navy yard at Norfolk, which runs considerably higher.

All heavy repairs to locomotives have been made at the Balboa shops and have covered general overhauling of 14 engines, besides those being repaired and packed for shipment to the Alaskan Engineering Commission. Four were completed during the last fiscal year for this latter purpose and 4 are now under repair with the expectation that they will be shipped about the middle of August. At the same time 50 Lidgerwood flat cars, 2 70-ton steam shovels, and 7 narrow-gauge locomotives will be shipped so as to arrive in Alaska before the close of the season for navigation, with a view to erection by the Commission's forces during the winter.

During the year the launch *Birdina*, tug *DeLesseps*, launch No. 26, tug *Reliance*, tug *Bolivar* have been generally overhauled.

The *Reliance*, after removal of the boiler and deck house by the floating derrick *Hercules*, at Paraiso, was sent to the dry-dock shops, Cristobal, where practically all of her frames were removed and replaced by new frames. The old frames had deteriorated to such an extent as to endanger her seaworthiness. In addition to renewing the frames, tanks were built for liquid fuel, the deck-house repaired where necessary, and a complete new deck laid. On her return to Paraiso the boiler, steam piping, and lighting system were reinstalled and the deck house closed in where left open for passage of the boiler. The work in dock was completed in 29 days and the work at Paraiso in 18 days, the total time out of commission being 47 days. When completed, the vessel was practically as good as new, and as she is one of the most efficient tugs belonging to the canal, the expenditures were amply justified.

The *Bolivar* was sunk March 24, due to losing a tail shaft. The time elapsing after the accident permitted her to be brought alongside the floating derrick *Ajax*, at Gamboa, with the thought that slings might be made fast to her before she sank. This, however, was impossible, but she was raised the next day and was back in service on March 31. The work was done at the Paraiso shops.

The tugs *Gorgona* and *Tavernilla*, when delivered, were fitted with forced draft supplied by turbine-driven blowers. With this arrangement the fuel consumption was high and the wear and tear on the boilers excessive. Accordingly, the forced-draft blowers were removed and 14 feet added to the stacks. This gave sufficient natural draft and the fuel consumption was very much reduced. The work was done at Paraiso.

The *Birdina* and *De Lesseps* were rebuilt along tug lines and in their new condition have given excellent service. The work was done at Paraiso.

A house boat for the use of Army survey parties on Gatun Lake was built at the dry-dock shops, Cristobal, about the middle of the year, and just prior to the close of the fiscal year orders were received for the construction of another one of similar type. Repairs of considerable magnitude were made on various tugs, lighters, and mine



planters, and on the cable ship *Cyrus W. Field*, belonging to the Army. Gas engines were also installed in a number of small boats for their use.

Railroad motor car No. 9 was constructed for the use of the Commanding General of the troops on the Zone and proved very efficient in service until crushed by the steamship *Alliança* on June 28, 1916, when it was damaged to such an extent as to require complete rebuilding.

On recommendation contained in my letter of October 7, 1915, the floating derricks *Ajax* and *Hercules* were transferred to the dredging division, it being my opinion that so long as conditions in the Cut remained as they were it would be more economical to place these derricks under the wrecking organization of the dredging division. When the extensive dredging operations in the Cut have been completed they should again be transferred to the mechanical division, but this bids fair to be some months hence. While the Cut was closed the services of these derricks were invaluable. By their use tugs and barges could be lifted from the water sufficiently to permit propellers and other underwater parts to be repaired, thus saving not only the time of docking, but also the time necessary for transfer to the dry dock, and tugs, etc., even to the north of the slide, were so repaired, where possible, by the *Hercules* stationed at Gamboa, on account of saving in time. Of course there were no docking facilities available for the equipment south of the slide, and what could not be done by the use of the *Ajax*, stationed at Paraiso, had to be done on the beach under unsatisfactory conditions. Use for changing propellers alone has saved a great deal of time of tugs on account of the fact that blades are frequently broken while handling equipment in the close spaces in the Cut or on dumping grounds where accurate charts were not available.

The *Hercules* was fitted with an 800-foot air compressor and a number of shop tools and with quarters for the men employed for her care and operation, and spare quarters for mechanics detailed to work on which the derrick is used. The air compressor has also been installed on the *Ajax* and quarters similar to those on the *Hercules* should be installed. The work on both derricks was done by the Paraiso shops of this division.

From time to time, as required, the submarines of the "C" class have been docked and repaired for the Navy Department; also the tug *Potomac* and such work as was requested on the tender *Severn*. Since the detail of the cruiser *Charleston* to act as tender some work has been done on that vessel, and as soon as the dry dock at Balboa is available it is expected to place her in dock. The most important work on the submarines has consisted of stripping the batteries and machinery with a view to making careful examination of inaccessible portions of the hull to see whether it has deteriorated to a dangerous extent. In connection with this work various experimental work is to be performed with a view to possibly improving the seagoing qualities of the vessels. At the end of the fiscal year the work on the *C-4* was well advanced toward completion; work on the *C-1* was well begun, and work on the other three vessels of the class had not been started.

Until the canal was closed by the slide in October, 1915, there was comparatively little overtime work. Then it became necessary to do



a great deal of overtime work on dredging and railroad equipment. Much of this was dock work, which was done at Cristobal. At the Paraiso shop the work was in the nature of running repairs. At the Balboa shops it was principally repairs to spuds and dippers and manufacturing work. By the first of the year conditions governing the delivery of material from the States had reached such a critical state that much manufacturing work was thrown upon the Balboa shops which would otherwise have been performed under contract in the States. By this time also the ammunition factories and ship-yards in the States had created such a demand for mechanics that it was difficult to obtain them for work on the Zone. This fact, together with numerous resignations and the commencement of the leave period, February 1, resulted in very heavy overtime work from that date till the close of the fiscal year. The resignations were generally with a view to obtaining better positions in the States, but some were caused by fear of reduction in pay or loss of free quarters, fuel, and light when the provisions of the Panama Canal act went into effect, July 1. By the end of the fiscal year return of the employees from leave and the partial filling of large requisitions for men in the States, together with the easing of conditions in the Cut, reduced the overtime very materially, but it still remains in excess of an amount compatible with most efficient service of individual men and with the most efficient supervision.

The fuel-oil pumping plants were operated by this division until September 1, 1915, when they were turned over to the supply department in accordance with the Governor's letter of December 5, 1914. Since then analyses of the oil have been made by the chemist attached to this division.

Subsequent to August, 1915, the construction work on the fuel-oil plants was performed by this division. The plants had already been well advanced toward completion, having been placed in service, the Balboa plant in February, 1915, and the Mount Hope plant in March, 1916. Subsequent to the transfer of the construction work to this division a wooden trestle was authorized and constructed, leading out to the oil crib, and the pipes leading to the crib reinstalled thereon. These pipes had previously been laid on the bottom under water and the flow of the tide was sufficient to keep them constantly leaking. Two additional 55,000-barrel fuel-oil tanks were purchased and at the close of the fiscal year one of these, at Balboa, was ready for service, while the foundations had been prepared for the one at Mount Hope and work of erection had begun. In addition the tank farms were fenced with barbed wire attached to concrete posts; two 5,000-barrel gasoline tanks, one at Balboa and one at Mount Hope, were erected and connected. A 500-barrel tank was also erected at Balboa, with connection to a standpipe for filling tank cars on the tracks of the Panama Electric Company for transporting fuel oil to their own plant in Panama. This tank was erected with the understanding that after its completion some equitable decision would be arrived at as to whether it would remain the property of the canal or be purchased either by the Panama Electric Co. or by the Panama Agencies Company. Decision in the matter has not yet been reached.

During the year the question of whether or not the restrictions upon the gravity of fuel oil for storage on the Zone might be modi-

fied, has been under consideration. At present, oil below 16° gravity is not allowed to be stored, and this rule prevents the storage of oil from some of the most prolific fields, thus tending to increase the price to shipping. The gravity now specified was originally determined upon to prevent storage of oils whose viscosity would be so high as to seriously interfere with pumping. Inasmuch, however, as the viscosity does not seem to have any definite relation to gravity, investigation has been under way to determine just what specifications might be adopted which, while insuring that the oil could be readily handled, would permit wider range for storage. The present indications are that oil as low as 14° Baumé gravity might be allowed with some restrictions as to the viscosity, and report is expected to be submitted shortly.

The large demand for oil for vessels tied up at the terminals when the canal closed in October exhausted the supply of oil at Mount Hope and it became necessary to transport oil by rail from Balboa to Cristobal. About twenty old locomotive tender tanks were fitted up for this purpose and gave fairly satisfactory service, although not ideal for the purpose. Their use permitted vessels to be supplied with oil under conditions which otherwise would have been very embarrassing.

An experimental installation was authorized for rendering the atmosphere above the gasoline in the gasoline storage tank at Balboa nonexplosive by means of carbon-dioxide gas in order that protection might be given against fire. The apparatus consists essentially of a 2-cylinder gasoline engine—one cylinder acting as a generator of power, the other as a compressor. The gases exhausted from the power cylinder are compressed by the other cylinder and, after being scrubbed and cooled by proper devices, are forced into a storage tank, where pressure of about 150 pounds per square inch is maintained. From this storage tank the gas passes through reducing valves to the gasoline tank in which it is maintained at a pressure of one-fourth of a pound per square inch. The apparatus worked satisfactorily and tests of the gases above the gasoline in the tank showed them to be nonexplosive.

The necessity for using air drills on the banks abreast the slide required that considerable compressed air capacity be provided immediately adjacent to the work. This was accomplished by installing two 2,500-foot air compressors from the old Empire air compressor plant, on board the seagoing suction dredge *Caribbean*, steam being applied from the boilers of the vessel. About the first of January, it became apparent that some vessel should be found for transporting native cattle from Colombia for use of the commissaries. The *Ancon* and *Cristobal* made several trips for the purpose, but their value as regular carriers was too great to justify continued use, while the arrangement of their decks prevented their being used as efficiently as was desirable and their draft prevented access to some of the ports from which shipment was to be made. Accordingly, after investigation, it was decided to convert the dredge *Caribbean* into a cattle boat, and in order that this might be done, it was necessary to provide other means for operating the air compressors at the slides. Two of the Babcock & Wilcox boilers previously in use at the Gold Hill sluicing plant were therefore installed on one of the

old rock barges to provide steam for a 2,500-foot compressor installed on the deck at either end.

While this work was being done at Balboa, the work of fitting up the *Caribbean* was carried along as rapidly as possible by the Paraiso shops, without interfering with the use of the compressors. When the compressor barge became available, the *Caribbean* was transferred to the dry dock shops, where necessary dock work was done and the vessel placed in service, starting on her first trip July 1, 1916. The work is still incomplete, but is being completed from time to time as the vessel becomes available between trips. To fit her for this purpose, bulwarks were erected around the main deck; a complete wooden deck fitted; hopper doors securely closed; suction and overflow pipes removed; quarters for customs inspectors installed; troughs for water and feed installed; two cargo winches installed; also a heavy gangway platform with a chute, the lower end of which may be rested upon the barge upon which the cattle are brought out from the shore. Ultimately the main deck will be divided into pens accommodating 8 or 10 cattle each, and other special accommodations provided. At present, the subdivision of the deck is accomplished by means of temporary wooden partitions, on account of the material for the permanent partitions not having been received. The present subdivision is less complete than will ultimately be the case, but even so it is found that the vessel may carry about 425 head comfortably, and so far there has been no injury to the stock, and it arrives in condition superior to that in which it arrived when transported by other vessels. The cattle are carried on the main deck only.

The fact that the vessel is available for regular trips permits the cattle to be collected from the pastures barely in time to be loaded and avoids losses of weight from lack of food and water while waiting shipment. The subdivision of the deck will reduce the danger of injury to cattle while being transported.

Vessels were docked during the year at the Cristobal Dry Dock, distributed as follows. Vessels docked more than once are counted once for each docking:

Dredging division.....	67
Marine division.....	3
Panama Railroad.....	10
United States Army.....	5
United States Navy.....	8
Individuals and companies.....	4
East breakwater.....	7
Panama Government.....	2

Owing to the rush of work on dredging equipment, it was necessary to refuse to dock a number of individual and company vessels which might otherwise have been cared for. One dredging division vessel, the *Corozal*, was docked in the dry docks at Balboa.

Orders were received for manufacturing four towing locomotives at Balboa but only a little work was possible before the end of the fiscal year, due to failure of the patterns to arrive from the States. This and the other manufacturing work in sight will facilitate employing the force uniformly and will result in benefit to the shops. Additional manufacturing jobs included construction of a boom for the dredges of the *Paraiso* class; a ladder for the dredge *Marmot*; and

one for dredge *No. 5*; three oil barges, two of which were made by using portions of the old drill barge *Teredo*; and two house boats for the Army. Numerous small motor boats and pangas were also constructed under the appropriation for the current fiscal year. Authority has been granted to build two gasoline-driven steel boats for watch boats in the dredging division, and two supply boats for the marine division, the latter having a length on the water-line of about 75 feet.

A number of jobs of considerable magnitude were done for individuals and companies during the year, among which may be mentioned extensive repairs to the boilers of the steamships *Whitgift* and *St. Louis*, to the rudder of the *Curaca*, and to the stern of the *Elm Branch*. Three manufacturing orders of considerable magnitude were accomplished for the Ferrocarril de Arica a La Paz, consisting of six cast steel frames for geared mountain climbing locomotives, 3,000 semisteel rail chairs and 16 steel gears for use on locomotives. These jobs were taken in competition with the States and cost less than the estimates and were completed under conditions that were satisfactory as to delivery.

The rapid deterioration of wood in this climate and the difficulty of obtaining prompt deliveries from the States and of preserving stocks until consumed, suggested the necessity of an investigation to determine whether or not some construction was not possible which would be more durable and cheaper in the long run than wood imported from the United States. Accordingly, on my recommendation, steel underframes were authorized for the permanent passenger equipment of the Panama Railroad, and experiments were started looking to the use of steel to a considerable extent on other equipment previously constructed entirely of wood. Consideration was also given to the use of native timber, and a force was sent into the woods to cut a supply of several varieties. This timber has been sawed and dried and is now practically ready for use.

The going into effect on July 1, 1916, of the Panama Canal act, in so far as it refers to the pay of canal employees, involved fixing rates based on rates paid by the Government in continental United States. Owing to the great demand for mechanics in the States at present, wages there have been so high that this readjustment of wages resulted in most cases in small increases, but there were small reductions in a few cases, generally in unimportant trades or trades where the conditions of service are different on the Zone from those in the States. Except, therefore, for the question of whether or not free quarters, fuel, and light were to be allowed, there has been little discontent with the new scale of wages, but the adjustment of rates in detail involves a large amount of investigation in order to fix the rates for individual positions. This is especially the case in the mechanical division, for which conditions are in general most nearly comparable with those in effect in Government establishments in the States. Some discontent has arisen, due to the fact that trades which formerly all received the same rates of pay, now receive in many cases different rates of pay; but this is a minor matter.

From the investigation referred to above, it became apparent that as a class the mechanics and clerks have been for years paid practically the maximum permissible under the new schedule. On the contrary, the supervisory and technical forces were found to be materially

underpaid, as compared with similar forces in the States, when the full allowance permitted by the Panama Canal act was applied. It has been my impression ever since my arrival on the Zone that foremen did not receive compensation commensurate with their responsibilities and with the compensation of the employees supervised, but it seemed undesirable to make any change until the whole matter of compensation was handled in accordance with the provisions of the Panama Canal act, which of course became possible only in connection with the present investigation of the subject. These investigations indicate very clearly that the more important positions as foremen are entitled to an increase of from 10 to 15 per cent, as compared with the rates previously paid, and the services rendered by the incumbents of these positions have been so uniformly good, and often under such trying conditions, that I have taken pleasure in finding that conditions seem to justify higher compensation in many cases.

The leave conditions, while imposing less restrictions upon the performance of the work this year than last, have still resulted in great inconvenience and at times in loss of efficiency. The issue of new appointments, effective April 1, 1914, made the service year of all employees then in service date from that day, and resulted that all leave for the fiscal year 1915 (unless the same was to be forfeited or accumulated, or unless it had to be deferred for the good of the service) had to be taken between February 1 and March 31 as to annual leave, and between February 1 and May 31 as to cumulative leave. In a department depending so largely as this division does upon gold labor, this resulted that a very large percentage of the force was on leave during these four months. Resignations and new employments have tended to distribute the commencement of the service year more uniformly through the year, and it is this which has relieved conditions as they existed last year. But so large a percentage of employees still retain the date of April 1 as the commencement of their service year that an undesirably large number of men were on leave nearly all the time throughout the four months referred to.

Table No. 13 is inclosed, which compares the number on leave during this period for 1915 and 1916. This table indicates the effect of the change in service years, but the conditions shown for the year 1916 was made possible only by deferring the leave of 83 employees, while a few forfeited their leave because they could not take it at the time they desired. In my report for last year, I made the following general comments relative to the effect of the present leave regulations, and, subject to modification due to effect of changes in commencement of service year as outlined above, are still pertinent:

There is a general tendency, when choice of date is possible, for employees intending to visit the States to ask for leave effective about May 1 or September 1. This avoids cold weather in the States, with the danger of colds, etc., incident to great change of temperature, also the expense for heavy clothes, while at the same time permitting sufficient change of climate to be beneficial to the health. Under conditions as they existed this year no advantage could be taken of the fall season except when the head of the division was unable to spare the services of the employee for several months and leave, therefore, had to be postponed for the good of the service. Few leaves required to be postponed for that length of time; hence the benefits to health for employees who might have chosen to go in the fall, rather than early in February or late in May, was reduced to the minimum.

With a gold force as large as that employed by the mechanical division, four months (i. e., two months prior to and two months after the expiration of the service year) do not—under conditions now existing and likely to exist for at least two or three years yet

to come—give sufficient latitude for granting leave to all employees who are entitled to it without seriously reducing the efficiency of the organization. It would seem desirable to consider some modification permitting more latitude, and it is suggested that the modification might well consist in allowing cumulative leave for any service year to be taken at any time subsequent to the expiration of 10 months' service during the year and by allowing it to be combined with any unused annual leave for the current year or the previous year not in excess of 24 days. No change should be made in the present regulations relative to accumulation of cumulative leave, nor in the provision that leave may be taken only when the employee's services can be spared.

\* Another thing that has given ground for complaint and for requests for postponement of leave is the fact that, unless such employees take leave in the hottest part of the summer, those who have children must take them out of school or else leave them on the Isthmus. Quite a number of requests for postponement on this ground were received from employees, but your office decided that it was not a reason which would justify postponement under the regulations. It seems to me that this is a condition which should receive serious consideration and which might be met by a change in the opening date of the school year, so as to allow children to be taken to the States during either the spring or the fall without having to miss school. My contact with the boys of the Zone, incident to the employment of apprentices, indicates that the children of employees do not receive proper benefit from the excellent school system. This is no doubt largely due to carelessness on the part of parents, and this carelessness may reasonably be expected to be less under operating conditions than was the case under construction conditions; but at best, even if there is room for choice (which does not exist now), parents will be too prone to take their leave at the best season for comfort in the States, regardless of any interference with the schooling of their children which it involves, and the fitting of children for the best accomplishments in after life will thereby be interfered with.

The maximum expenditures for the division as a whole were for the month of May, 1916, and amounted to \$446,595.72, divided as follows:

Balboa shops.....	\$272, 146. 50
Dry-dock shops, Cristobal.....	69, 149. 08
Paraiso shops.....	81, 332. 08
Roundhouse, Cristobal.....	23, 967. 21

446, 595. 72

The maximum number of employees in the division was in June, 1916, and consisted of 972 on the gold roll and 2,003 on the silver roll, distributed as follows:

	Gold.	Silver.
Balboa shops.....	582	1, 081
Dry-dock shops, Cristobal.....	185	401
Paraiso shops.....	162	371
Roundhouse, Cristobal.....	11	41
Miscellaneous.....	32	109

The minimum expenditures for the division as a whole were for the month of August, 1915, amounting to \$336,959.94, distributed as follows:

Balboa shops.....	\$218, 147. 83
Dry-dock shops, Cristobal.....	52, 122. 06
Paraiso shops.....	45, 943. 75
Roundhouse, Cristobal.....	20, 746. 30

336, 959. 94

The minimum number of employees was during the month of November, 1915, consisting of 865 on the gold roll and 1,824 on the silver roll, distributed as follows:

	Gold.	Silver.
Balboa shops.....	530	996
Dry-dock shops, Cristobal.....	155	348
Paraiso shops.....	128	299
Roundhouse, Cristobal.....	11	44
Miscellaneous.....	41	137

The accounting system, originally provided for this division when the Balboa shops were placed in service, has continued to be used with very minor modifications made after careful consideration and with the approval of the auditor. This system has continued to demonstrate its suitability and has exercised a large influence toward the efficiency of the force.

Tables as follows, showing various phases of the operations of the mechanical division for the fiscal year 1915, accompany this report, also a blue print showing the organization in effect July 1, 1916, Plate No. 106:

- TABLE 1. Abstract of expenditures of the mechanical division, showing distribution of charges and overtime work performed.
2. Abstract of expenditures of the mechanical division, for Balboa shops only, showing distribution of charges and overtime work performed.
  3. Abstract of expenditures of the mechanical division, for dry-dock shops only, showing distribution of charges and overtime work performed.
  4. Abstract of expenditures of the mechanical division, for Cristobal roundhouse only, showing distribution of charges and overtime work performed.
  5. Abstract of expenditures of the mechanical division, for Paraiso shops only, showing distribution of charges and overtime work performed.
  6. Abstract of expenditures for the operation of the foundry, Balboa shops.
  7. Expenditures and output of the oxy-acetylene plant, Balboa shops.
  8. Number of repairs to locomotives.
  9. Number of repairs to equipment other than locomotives and cars.
  10. Number of shop and field repairs made to different classes of cars.
  11. Amount of equipment hostled, and the cost.
  12. Statement of mechanical division force on the rolls at the close of each month during the year.
  13. Comparative statement of changes in personnel from month to month during the year.
  14. Statement of employees requisitioned from the United States during the year, mechanical division.

Respectfully submitted.

D. C. NUTTING,  
*Superintendent Mechanical Division.*

Maj. Gen. GEO. W. GOETHALS, United States Army,  
*Governor, The Panama Canal, Balboa Heights, Canal Zone.*

TABLE NO. 1.—*Abstract of expenditures of the mechanical division, showing distribution of charges and overtime work performed.*

Month.	Abstract of expenditures.			
	Labor.	Material.	Other expense.	Total.
<b>1915.</b>				
July.....	\$192,100.55	\$144,479.35	\$17,516.01	\$354,095.91
August.....	176,957.17	126,282.16	33,720.61	336,959.94
September.....	174,536.47	133,572.24	35,562.25	343,670.96
October.....	183,925.19	140,235.22	40,701.33	364,861.74
November.....	173,052.03	153,254.08	35,402.59	361,708.70
December.....	181,294.99	133,215.38	34,114.74	348,625.11
<b>1916.</b>				
January.....	182,253.62	179,983.78	29,487.59	391,724.99
February.....	179,370.44	171,553.55	25,275.43	376,199.42
March.....	196,667.01	128,333.59	24,399.69	349,400.29
April.....	188,826.10	184,202.95	23,750.05	396,779.10
May.....	208,573.38	202,905.22	35,117.12	446,595.72
June.....	202,770.32	152,733.92	26,988.11	382,492.35
Total.....	2,240,327.27	1,850,751.44	362,035.52	4,453,114.23
Average per month this year.....	186,693.94	154,229.29	30,169.62	371,092.85
Average per month last year.....	174,395.23	144,755.92	60,139.29	379,290.44

Month.	Distribution of charges.			Overtime.	
	Individuals and companies.	Panama Railroad.	Departments and divisions.	Amount.	Per cent of total.
<b>1915.</b>					
July.....	\$61,945.52	\$119,527.19	\$190,424.51	\$10,676.02	5.56
August.....	26,175.72	92,736.68	239,426.91	14,374.51	8.12
September.....	13,087.62	124,679.99	246,594.84	14,300.97	8.19
October.....	10,528.92	96,364.89	240,434.78	21,238.34	11.55
November.....	11,277.95	107,009.26	222,519.08	16,694.11	9.65
December.....	9,716.41	84,347.97	269,359.07	15,410.60	8.50
<b>1916.</b>					
January.....	7,908.87	110,052.02	253,401.85	12,971.87	7.12
February.....	8,552.27	103,945.85	273,919.32	14,914.95	8.32
March.....	8,746.34	78,422.35	226,369.37	18,888.99	9.60
April.....	12,526.91	97,578.14	267,341.11	22,882.28	12.12
May.....	13,794.49	97,286.93	280,626.66	33,323.81	15.98
June.....	14,894.19	112,512.31	255,032.89	23,614.04	11.65
Total.....	199,155.21	1,214,463.58	2,965,450.39	219,290.49	9.79
Average per month this year.....	16,596.27	101,205.29	247,120.87	18,120.87	9.79
Average per month last year.....	6,203.90	83,232.12	289,854.42	10,956.30	6.28



TABLE NO. 2.—*Abstract of expenditures of the mechanical division for Balboa shops only, showing distribution of charges and overtime work performed.*

Month.	Abstract of expenditures.			
	Labor.	Material.	Other expense.	Total.
1915.				
July.....	\$124,432.21	\$101,600.40	\$9,609.92	\$235,642.53
August.....	115,265.45	84,837.24	18,045.14	218,147.83
September.....	111,548.48	99,504.03	18,165.09	229,217.60
October.....	118,140.42	107,537.69	26,155.39	251,833.50
November.....	109,151.65	110,358.86	22,754.46	242,264.97
December.....	112,712.48	91,820.37	20,721.06	225,253.91
1916.				
January.....	113,352.00	136,212.55	17,791.45	267,356.00
February.....	113,761.03	130,799.48	16,036.05	260,596.56
March.....	123,019.34	94,747.17	18,270.01	236,036.52
April.....	116,622.32	132,956.81	19,433.13	269,012.26
May.....	118,345.31	132,981.56	20,819.63	272,146.50
June.....	118,787.39	107,721.52	15,307.04	241,815.95
Total.....	1,395,138.08	1,331,077.68	223,108.37	2,949,324.13
Average per month this year.....	116,261.51	110,923.14	18,592.36	245,777.01
Average per month last year.....	117,492.36	112,213.61	38,830.19	268,536.16

Month.	Distribution of charges.			Overtime.	
	Individuals and companies.	Panama Railroad.	Departments and divisions.	Amount.	Per cent of total.
1915.					
July.....	\$56,466.99	\$94,814.64	\$124,902.89	\$4,718.74	3.79
August.....	1,695.95	71,015.51	139,327.42	7,713.01	6.69
September.....	9,607.20	104,547.85	163,113.15	5,507.93	4.94
October.....	5,550.34	75,351.45	142,858.06	11,445.69	9.69
November.....	10,348.97	89,906.35	136,958.58	8,681.36	7.95
December.....	7,638.22	70,221.92	172,645.08	7,350.69	6.52
1916.					
January.....	5,436.54	90,653.30	155,494.26	5,724.49	5.05
February.....	5,647.27	88,221.00	170,708.38	8,422.23	7.40
March.....	7,294.90	63,203.92	147,922.28	11,585.81	9.42
April.....	7,636.60	76,730.43	142,055.64	10,374.05	8.90
May.....	5,253.07	71,075.73	184,448.55	10,316.15	8.72
June.....	6,921.10	98,140.98	125,393.19	7,552.00	6.36
Total.....	129,557.15	993,883.08	1,805,827.48	99,392.15	7.12
Average per month this year.....	10,796.43	82,823.59	150,485.62	8,282.68	7.12
Average per month last year.....	2,426.22	62,219.88	203,890.06	5,621.32	4.78

TABLE NO. 3.—*Abstract of expenditures of the mechanical division, for dry-dock shops only, showing distribution of charges and overtime work performed.*

Month.	Abstract of expenditures.			
	Labor.	Material.	Other expenses.	Total.
<b>1915.</b>				
July .....	\$34,268.72	\$13,109.66	\$1,748.86	\$52,127.24
August .....	32,203.62	12,917.22	7,001.22	52,122.06
September .....	32,521.47	10,349.38	8,480.00	51,350.85
October .....	32,768.23	11,855.71	6,687.42	51,311.36
November .....	32,109.48	10,928.69	5,888.09	48,926.26
December .....	33,726.90	11,352.32	5,828.19	50,907.41
<b>1916.</b>				
January .....	32,933.12	13,286.70	3,355.82	49,575.64
February .....	30,651.29	13,230.12	3,319.29	44,200.70
March .....	36,074.44	10,300.60	565.76	46,940.80
April .....	34,537.58	15,002.63	906.61	50,446.82
May .....	46,263.99	14,208.66	8,677.28	69,149.93
June .....	44,186.61	17,310.15	6,493.53	67,990.29
Total .....	422,245.45	150,851.84	61,952.07	635,049.36
Average per month this year .....	35,187.12	12,570.99	5,162.67	52,920.78
Average per month last year .....	30,077.94	12,194.15	12,933.07	55,205.16

Month.	Distribution of charges.			Overtime.	
	Individuals and companies.	Panama Railroad.	Departments and divisions.	Amount.	Per cent of total.
<b>1915.</b>					
July .....	\$2,329.86	\$16,418.93	\$17,502.74	\$2,440.87	7.12
August .....	21,463.28	11,144.20	49,187.18	3,383.07	10.51
September .....	2,007.93	10,382.37	31,895.76	3,885.43	11.95
October .....	4,826.18	8,009.97	41,333.48	4,789.47	14.62
November .....	816.50	6,023.45	30,645.82	3,974.01	12.38
December .....	1,921.70	4,882.31	34,546.13	3,129.67	9.28
<b>1916.</b>					
January .....	2,467.83	9,397.63	33,362.46	1,257.43	3.82
February .....	2,581.75	5,558.12	42,534.79	1,423.77	4.65
March .....	1,366.04	5,494.76	17,833.79	2,396.80	6.64
April .....	4,890.31	11,112.21	58,606.71	6,053.70	17.52
May .....	8,541.42	4,826.62	11,211.33	14,124.19	30.53
June .....	7,774.93	3,868.24	53,999.57	10,828.13	24.51
Total .....	60,991.03	97,118.81	430,659.76	57,686.54	13.66
Average per month this year .....	5,082.59	8,093.23	35,888.31	4,807.21	13.66
Average per month last year .....	3,124.20	10,099.06	41,981.89	2,341.46	7.78

TABLE NO. 4.—*Abstract of expenditures of the mechanical division, for Cristobal round-house only, showing distribution of charges and overtime work performed.*

Month.	Abstract of expenditures.			
	Labor.	Material.	Other expenses.	Total.
1915.				
July.....	\$3,983.30	\$17,850.71	\$482.82	\$22,316.83
August.....	3,524.78	15,360.44	1,861.08	20,746.30
September.....	3,053.54	11,425.90	1,426.72	15,906.16
October.....	3,451.35	7,475.13	1,183.20	12,109.68
November.....	3,321.47	15,886.23	874.82	20,082.52
December.....	3,482.48	9,693.06	1,254.42	14,429.96
1916.				
January.....	3,402.61	10,348.92	1,318.10	15,069.63
February.....	3,418.94	10,826.02	2,419.97	16,664.93
March.....	3,382.98	4,691.44	1,237.56	9,311.98
April.....	3,251.19	11,517.77	250.32	15,019.28
May.....	3,266.03	19,114.87	1,586.31	23,967.21
June.....	3,431.21	3,820.91	656.83	7,908.95
Total.....	40,969.88	138,011.40	14,552.15	193,533.43
Average per month this year.....	3,414.16	11,500.95	1,212.68	16,127.79
Average per month last year.....	3,528.92	9,688.18	2,579.34	15,796.44

Month.	Distribution of charges.			Overtime.	
	Individuals and companies.	Panama Railroad.	Departments and divisions.	Amount.	Per cent of total.
1915.					
July.....	\$3,148.67	\$8,280.63	\$5,010.51	\$574.35	14.42
August.....	3,016.49	10,573.00	5,933.53	633.65	17.98
September.....	1,472.49	9,678.37	3,912.45	366.40	12.00
October.....	152.10	12,990.82	3,823.33	616.19	17.85
November.....	112.48	11,073.93	3,414.29	529.23	15.93
December.....	5.47	9,187.66	5,542.92	391.72	11.25
1916.					
January.....	4.50	9,799.90	4,795.95	593.06	17.43
February.....	20.25	10,145.13	6,322.84	545.42	15.95
March.....	5.62	9,686.54	5,679.14	382.59	11.31
April.....	.....	9,678.68	3,825.51	520.78	16.02
May.....	.....	11,157.15	4,643.62	425.21	13.02
June.....	.....	9,842.62	3,763.80	511.39	14.90
Total.....	7,926.83	122,094.43	56,667.89	6,089.99	14.86
Average per month this year.....	660.57	10,174.53	4,722.32	507.50	14.86
Average per month last year.....	653.48	10,872.52	4,270.44	511.20	14.49

TABLE NO. 5.—*Abstract of expenditures of the mechanical division, for Paraíso shops only, showing distribution of charges and overtime work performed.*

Month.	Abstract of expenditures.			
	Labor.	Material.	Other expenses.	Total.
<b>1915.</b>				
July.....	\$29,416.32	\$11,918.58	\$2,674.41	\$44,009.31
August.....	25,963.32	13,167.26	6,813.17	45,943.75
September.....	27,412.98	12,292.93	7,490.44	47,196.35
October.....	29,565.19	13,366.69	6,675.32	49,607.20
November.....	28,469.43	16,080.30	5,885.22	50,434.95
December.....	31,373.13	20,349.63	6,311.07	58,033.83
<b>1916.</b>				
January.....	32,565.89	20,135.61	7,022.22	59,723.72
February.....	31,539.18	19,697.93	3,500.12	54,737.23
March.....	34,190.25	18,594.38	4,326.36	57,110.99
April.....	34,415.01	24,725.74	3,159.99	62,300.74
May.....	40,698.05	36,600.13	4,033.90	81,332.08
June.....	36,365.11	23,881.34	4,530.71	64,777.16
Total.....	381,973.86	230,810.52	62,422.93	675,207.31
Average per month this year.....	31,831.16	19,234.21	5,201.91	56,267.28
Average per month last year.....	23,296.01	10,659.97	5,796.69	39,752.67

Month.	Distribution of charges.			Overtime.	
	Individuals and companies.	Panama Railroad.	Departments and divisions.	Amount.	Per cent of total.
<b>1915.</b>					
July.....		\$12.99	\$43,008.37	\$2,942.06	10.01
August.....		3.97	44,978.78	2,644.78	10.19
September.....		71.40	47,673.48	4,541.21	16.57
October.....		12.65	49,419.91	4,386.99	14.84
November.....		5.53	51,500.39	3,509.51	12.33
December.....	\$91.02	56.08	56,624.94	4,538.52	14.47
<b>1916.</b>					
January.....		201.19	59,749.18	5,396.89	16.57
February.....		21.60	51,653.31	4,523.53	14.34
March.....		37.13	55,025.18	4,523.79	13.23
April.....		56.82	62,853.25	5,933.75	17.24
May.....		16,002.49	64,548.10	8,458.26	20.78
June.....	198.16	660.47	66,876.33	4,722.52	12.99
Total.....	289.18	17,142.32	656,911.22	56,121.81	14.60
Average per month this year.....	24.10	1,428.53	54,742.60	4,676.82	14.60
Average per month last year.....		40.66	39,712.01	2,483.33	10.66

TABLE NO. 6.—*Abstract of expenditures, mechanical division, for the operation of the foundry, Balboa shops.*

Metals.	July.	August.	September.	October.	November.	December.
Aluminum:						
Pounds.....				49	16	
Unit cost.....				\$0.256	\$0.264	
Babbitt:						
Pounds.....		361				
Unit cost.....		\$0.372				
Brass:						
Pounds.....	13,304	8,556	11,557	15,315	13,111	20,902
Unit cost.....	\$0.123	\$0.133	\$0.124	\$0.118	\$0.117	\$0.114
Bronze:						
Pounds.....	1,139	1,447	825	1,598	3,524	3,565
Unit cost.....	\$0.183	\$0.190	\$0.183	\$0.174	\$0.145	\$0.166
Bronze, phosphorous:						
Pounds.....	770		1,330	426	1,674	600
Unit cost.....	\$0.177		\$0.165	\$0.168	\$0.166	\$0.157
Bronze, hard:						
Pounds.....	141		460	1,052	1,101	538
Unit cost.....	\$0.223		\$0.182	\$0.186	\$0.185	\$0.171
Bronze, manganese:						
Pounds.....				7		
Unit cost.....				\$0.159		
Bronze, special:						
Pounds.....					603	
Unit cost.....					\$0.176	
Copper:						
Pounds.....	12	20	32	5	12	
Unit cost.....	\$0.249	\$0.154	\$0.152	\$0.170	\$0.142	
Lead:						
Pounds.....			42			
Unit cost.....			\$0.064			
Metal, brazing:						
Pounds.....		128	411	6		153
Unit cost.....		\$0.154	\$0.132	\$0.143		\$0.126
Metal, white, low grade:						
Pounds.....				59		
Unit cost.....				\$0.120		
Tin:						
Pounds.....			21			
Unit cost.....			\$0.541			
Zinc:						
Pounds.....	63					
Unit cost.....	\$0.146					
Total, brass foundry:						
Output.....pounds..	15,429	10,512	14,678	18,517	20,041	25,758
Patterns.....	25	23	28	46	53	30
Castings.....	676	678	592	1,312	1,071	1,639
Expenditures.....	\$2,028.23	\$1,572.30	\$1,983.52	\$2,376.95	\$2,643.67	\$3,117.30
Iron:						
Output.....pounds..	101,242	146,015	149,991	207,960	225,717	256,713
Unit cost.....	\$0.0375	\$0.0321	\$0.0269	\$0.0252	\$0.0250	\$0.0165
Patterns.....	52	84	44	57	65	56
Castings.....	1,355	2,837	2,568	3,372	3,128	2,941
Expenditures.....	\$3,795.99	\$4,685.77	\$4,035.41	\$5,240.02	\$5,648.25	\$4,240.52
Steel:						
Output.....pounds..	81,822	71,081	83,598	99,603	70,693	131,690
Unit cost.....	\$0.0827	\$0.0707	\$0.0636	\$0.0639	\$0.0628	\$0.0477
Patterns.....	33	16	37	46	26	22
Castings.....	518	989	978	1,073	702	760
Expenditures.....	\$6,764.61	\$5,027.08	\$5,316.99	\$6,361.54	\$4,442.38	\$6,279.30
General foundry:						
Surcharge applied on direct labor.....per cent.						70
Expenditures.....						\$1,769.64
Grand totals:						
Output.....pounds..	198,493	227,608	248,267	326,080	316,451	414,161
Patterns.....	110	123	109	149	144	108
Castings.....	2,549	4,504	4,138	5,757	4,901	5,340
Expenditures.....	\$12,588.83	\$11,285.15	\$11,337.92	\$13,978.51	\$12,734.30	\$15,406.76

TABLE NO. 6.—Abstract of expenditures, mechanical division, for the operation of the foundry, Balboa shops—Continued.

Metals.	January.	February.	March.	April.	May.	June.	Total.
Aluminum:							
Pounds.....	50			146			261
Unit cost.....	\$0.240			\$0.425			
Babbitt:							
Pounds.....							361
Unit cost.....							
Brass:							
Pounds.....	33,502	17,374	12,308	8,491	15,009	14,692	184,121
Unit cost.....	\$0.122	\$0.138	\$0.169	\$0.168	\$0.165	\$0.178	
Bronze:							
Pounds.....	4,327	2,907	5,724	6,062	3,314	10,510	44,942
Unit cost.....	\$0.164	\$0.207	\$0.234	\$0.238	\$0.242	\$0.243	
Bronze, phosphorous:							
Pounds.....	74	880		1,660	2,370	922	10,706
Unit cost.....	\$0.162	\$0.207		\$0.268	\$0.236	\$0.235	
Bronze, hard:							
Pounds.....							3,292
Unit cost.....							
Bronze, manganese:							
Pounds.....				214	6,287		6,508
Unit cost.....				\$0.251	\$0.254		
Bronze, special:							
Pounds.....							603
Unit cost.....							
Bronze, white:							
Pounds.....				15			15
Unit cost.....				\$0.579			
Copper:							
Pounds.....				158			239
Unit cost.....				\$0.215			
Lead:							
Pounds.....			1,319				1,361
Unit cost.....			\$0.085				
Metal, brazing:							
Pounds.....	24	2,154	1,040	28	32	144	4,120
Unit cost.....	\$0.114	\$0.175	\$0.227	\$0.206	\$0.205	\$0.207	
Metal, white, low grade:							
Pounds.....							59
Unit cost.....							
Metal, white, high grade:							
Pounds.....				320			320
Unit cost.....				\$0.354			
Tin:							
Pounds.....			6	1			28
Unit cost.....			\$0.527	\$0.518			
Zinc:							
Pounds.....							63
Unit cost.....							
Total, brass foundry:							
Output..... pounds..	37,977	23,315	20,397	17,095	27,012	26,268	256,999
Patterns.....	9	25	22	25	29	34	349
Castings.....	1,630	871	1,187	1,101	1,291	1,235	13,283
Expenditures.....	\$4,817.57	\$3,618.68	\$3,756.82	\$3,595.56	\$5,455.13	\$5,420.53	\$40,388.26
Iron:							
Output..... pounds..	204,461	148,637	102,037	164,299	202,195	192,641	2,101,908
Unit cost.....	\$0.0227	\$0.0195	\$0.0275	\$0.0218	\$0.0212	\$0.0224	
Patterns.....	95	27	43	63	54	50	690
Castings.....	2,645	2,619	1,806	4,014	2,272	2,547	32,104
Expenditures.....	\$4,647.41	\$3,266.37	\$2,805.81	\$3,586.74	\$4,289.51	\$4,324.24	\$50,566.04
Steel:							
Output..... pounds..	92,205	208,253	189,483	190,053	157,878	126,266	1,502,625
Unit cost.....	\$0.0596	\$0.0389	\$0.0531	\$0.0621	\$0.0682	\$0.0794	
Patterns.....	29	42	53	32	27	26	389
Castings.....	722	1,090	1,290	1,107	1,013	870	11,112
Expenditures.....	\$5,491.23	\$8,628.12	\$10,053.33	\$11,796.75	\$10,765.46	\$10,030.00	\$90,956.79
General foundry:							
Surcharge applied on direct labor, per cent.....	60	55	40	45	50	55	
Expenditures.....	\$1,793.20	\$1,500.43	\$1,752.86	\$2,317.11	\$2,014.17	\$2,061.68	\$13,269.09
Grand totals:							
Output..... pounds..	334,643	380,205	311,917	371,447	387,085	345,175	3,861,532
Patterns.....	133	94	118	120	110	110	1,428
Castings.....	4,997	4,580	4,283	6,222	4,576	4,652	56,499
Expenditures.....	\$16,749.41	\$17,073.60	\$18,368.82	\$21,296.16	\$22,524.27	\$21,836.45	\$195,180.18

TABLE NO. 7.—*Expenditures and output of the oxyacetylene plant. Balboa shops, mechanical division.*

	Total ex- penditures.	Output of oxygen.	Output of acetylene.
1915.			
July.....	\$1,819.79	<i>Cubic feet.</i> 24,000	<i>Cubic feet.</i> 15,757
August.....	1,856.05	27,610	22,003
September.....	1,919.12	26,000	24,548
October.....	2,496.06	34,400	28,298
November.....	2,478.24	38,100	27,185
December.....	3,087.33	39,900	22,216
1916.			
January.....	1,997.10	19,300	19,167
February.....	3,030.62	38,000	25,678
March.....	4,187.56	54,000	30,920
April.....	5,109.21	46,500	36,089
May.....	7,027.78	50,900	45,326
June.....	8,088.93	44,700	27,474
Total.....	43,097.79	443,410	325,051
Average per month this year.....	3,591.48	36,951	27,088
Average per month last year.....	1,217.48	12,016	23,896

TABLE NO. 8.—*Number of repairs to locomotives during fiscal year.*

Month.	Running.	Heavy.	Total.
1915.			
July.....	1,105	4	1,109
August.....	1,214	1	1,215
September.....	1,168	2	1,170
October.....	1,360	4	1,364
November.....	1,454	3	1,457
December.....	1,457	2	1,459
1916.			
January.....	1,427	3	1,430
February.....	1,325	2	1,327
March.....	1,351	3	1,354
April.....	1,244	2	1,246
May.....	1,315	1	1,316
June.....	1,230	1	1,231
Total.....	15,650	28	15,678
Average per month this year.....	1,304.17	2.33	1,306.50
Average per month last year.....	1,138.60	3.16	1,141.80

TABLE NO. 9.—*Repairs made during fiscal year to equipment other than locomotives and cars.*

Month.	Cranes.	Track shifters.	Unload- ers.	Spread- ers.	Others.	Total.
1915.						
July.....	16	2		20	1	39
August.....	17	1	1	3	5	27
September.....	27	3	2	6	5	43
October.....	23			1	4	28
November.....	23			1		24
December.....	20					20
1916.						
January.....	18		1	1		20
February.....	24			1	2	27
March.....	20					20
April.....	28				1	29
May.....	16					16
June.....	22					22
Total.....	254	6	4	33	18	315
Average per month this year.....	21.17	0.5	0.33	2.75	1.5	26.25
Average per month last year.....	24.67	0.25	1.59	6.08	2.66	35.25

TABLE NO. 10.—*Number of shop and field repairs made to different classes of cars during fiscal year.*

Equipment.	Number of shop repairs.	Number of field repairs.	Total.
Lidgerwood flat cars.....	2,615	14,302	16,917
Steel dump cars.....	3,026	17,797	20,823
Labor cars.....	461	126	587
Steel flats.....	634	4,664	5,298
Miscellaneous.....	2,618	33,665	36,283
Total.....	9,354	70,554	79,908
Average per month this year.....	779	5,880	6,659
Average per month last year.....	1,170	5,723	6,893

TABLE NO. 11.—*Amount of equipment hosted and the cost.*

Month.	Host-lings.	Direct labor.	Surcharge.	Material and service.	Total cost.	Average labor.	Average total cost per host-ling.
<b>1915.</b>							
July.....	4,376	\$2,547.12	\$1,421.22	\$98.16	\$4,066.50	\$0.58206	\$0.92927
August.....	4,603	2,501.85	1,460.44	131.67	4,093.96	.54353	.88941
September.....	4,519	2,592.51	1,521.88	323.03	4,437.42	.57369	.98194
October.....	4,485	2,554.02	1,464.42	159.19	4,177.63	.56946	.93146
November.....	4,445	2,578.30	1,324.48	331.04	4,233.82	.58004	.95249
December.....	4,603	2,788.56	1,312.10	549.60	4,650.26	.60581	1.01026
<b>1916.</b>							
January.....	4,637	2,851.26	1,449.78	162.79	4,463.83	.61489	.96255
February.....	4,285	2,966.92	1,271.63	276.16	4,514.71	.69239	1.05360
March.....	4,507	2,995.96	1,212.46	152.36	4,360.78	.69431	.96755
April.....	4,333	2,828.22	1,380.21	136.12	4,344.55	.65271	1.00266
May.....	4,101	2,386.61	1,382.77	115.17	3,884.55	.58195	.94722
June.....	4,068	2,241.03	1,004.54	99.70	3,345.27	.55089	.82234
Total.....	52,962	31,832.36	16,205.93	2,534.99	50,573.28	.61991	.95490
Average per month this year.....	4,413.5	2,652.70	1,350.49	211.25	4,214.44	.61991	.95490
Average per month last year.....	4,954.0	2,663.60	1,710.76	544.58	4,919.25	.53763	.99290

TABLE NO. 12.—*Statement of mechanical division force on the rolls at the close of each month during the year.*

	1915						1916					
	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
<b>GOLD.</b>												
Balboa shops.....	560	544	535	530	530	553	558	553	550	573	571	582
Dry-dock shops.....	147	143	143	143	155	155	157	156	158	164	164	185
Paraiso shops.....	119	113	113	121	128	131	128	138	150	150	160	162
Cristobal round house.....	12	12	11	11	11	11	11	11	11	11	11	11
Cristobal car shop.....	1	5										
Fuel-oil plants.....	5											
Miscellaneous.....	41	44	48	46	41	39	41	41	53	31	36	32
Total gold.....	885	861	850	851	865	889	895	899	922	929	942	972
<b>SILVER.</b>												
Balboa shops.....	1,000	979	998	999	996	1,007	1,031	1,025	1,038	1,019	1,014	1,081
Dry-dock shops.....	409	400	374	357	348	351	368	351	363	369	382	401
Paraiso shops.....	280	277	292	292	299	316	330	326	318	324	355	371
Cristobal round house.....	46	41	35	45	44	43	43	41	41	41	41	41
Cristobal car shop.....	5											
Fuel-oil plants.....	14	14										
Miscellaneous.....	127	153	154	156	137	143	138	150	127	111	107	109
Total silver.....	1,881	1,864	1,853	1,840	1,824	1,850	1,910	1,893	1,887	1,864	1,899	2,003
Grand total.....	2,766	2,725	2,703	2,691	2,689	2,749	2,805	2,792	2,809	2,793	2,841	2,975







## APPENDIX G.

### REPORT OF THE CHIEF QUARTERMASTER, SUPPLY DEPARTMENT.

---

BALBOA HEIGHTS, CANAL ZONE, *July 31, 1916.*

SIR: I have the honor to submit the following report of the operations of the supply department for the fiscal year ending June 30, 1916.

#### ORGANIZATION.

Under date of August 13, 1915, all the storehouses of the supply department were placed under the management of the general storekeeper, Mr. R. K. Morris being appointed general storekeeper.

The position of sales agent at Mount Hope was abolished under date of July 24, 1915, and the handling of the sales at the obsolete store at Mount Hope was placed in charge of the storekeeper of the supply department.

Effective September 1, 1915, the oil handling plants, The Panama Canal, Mount Hope, and Balboa, were transferred to the supply department for operation and placed under the immediate supervision of the general storekeeper. The operating organization of the plants was transferred from the mechanical division to the supply department.

#### PERSONNEL.

The following are some of the changes in personnel during the fiscal year:

Mr. Charles H. Mann resigned as sales agent July 24, 1915.

Mr. E. O. Bratt was appointed storekeeper at Mount Hope, July 24, 1915, and resigned August 5, 1915.

Mr. R. B. Groves was appointed storekeeper at Mount Hope, August 5, 1915.

Mr. R. K. Morris was appointed general storekeeper August 13, 1915.

Mr. H. F. Sedwick resigned as district quartermaster, Paraiso-Pedro Miguel District March 1, 1916, and Mr. John M. King was appointed as his successor.

Mr. B. C. Poole, quartermaster at Cristobal, was appointed inspector of the supply department vice Mr. C. C. McColley, resigned, effective December 1, 1915.

Mr. J. H. Humphrey was appointed district quartermaster at Cristobal, effective December 1, 1915.

## LABOR.

Construction work on the Pacific and Atlantic terminals and the dredging in Gaillard Cut continued through the greater part of the year without any marked reduction of force, with the exception of the Pacific terminals where, in May, due to completion of the dry docks, the force was reduced. This reduction, together with other slight reductions made on other finished construction work, showed 23,462 total force employed as of June 30, 1916, as compared with 26,897 employed on June 30, 1915, showing a net reduction of 3,435.

The largest force working at any one time during the year was in July, 1915, when the total was 26,905.

Labor conditions have been favorable throughout the year with a surplus in all grades. It was again found advisable to continue the repatriation of those for whom it was impossible to find employment, the totals repatriated for the fiscal year being as follows:

Nationality.	Number.	Cost.
Americans.....	507	\$18,916.45
West Indians.....	885	8,865.05
Europeans.....	191	5,484.30
To other countries.....	78	653.85
Total.....	1,661	33,919.65

A great many of the West Indians did not avail themselves of the offer of repatriation, so that at the close of the fiscal year there was still a surplus of colored labor.

The quarantine reports for the year show a net decrease of arrivals over departures of 1,616.

No contract laborers were recruited during the year.

## QUARTERS.

Corozal was the last town to be abandoned and the houses occupied by canal employees were turned over to the Army, effective December 1, 1915. The gold employees and their families, together with the bachelors, were moved to the Ancon-Balboa district. This transfer resulted in a congestion in the gold quarters at Ancon and Balboa. The number of applications on file for family quarters at Ancon and Balboa increased to 379 as of June 30, 1916, compared with 274 as of June 30, 1915.

There was a total for all the towns of 642 applications on file for family quarters as of June 30, 1915. On June 30, 1916, there was a total of 850. One hundred and fourteen of these already occupy regular or nonhousekeeping family quarters at stations other than those at which applications are filed.

The following family quarters for gold employees were completed during the year. All, except one, type 14, frame, four-family house, were erected at Ancon and Balboa. The frame four-family house was built at Mount Hope:

Fifteen houses, frame, type 14, four-family; 7 houses, frame, type 4, two-family; 12 houses, frame, type 17, one-family; 2 houses, concrete, two-family; 10 houses, concrete, four-family; 1 house, concrete, special bachelor; 1 house, frame, special bachelor.

## ZONE SANITATION.

The collection and disposal of garbage and night soil and the cutting of grass continued under the supervision of this department throughout the year, except at Cristobal and Mount Hope, where it continued under the health department. The cost of work done by the supply department, account of Zone sanitation, was \$47,550.52 for the year ending June 30, 1915. For the fiscal year ending June 30, 1916, it was \$45,167.20.

## CORRALS.

There was no decrease in the demand for wagon transportation; all animals were worked to their full capacity.

Due to improved road conditions, particularly on the Pacific terminal, motor trucks were found far superior to animal-drawn wagons, both for delivery service and trucking. There are now in use seven 3½-ton trucks, two 1-ton trucks, and one ambulance at Ancon, and one 2½-ton electric truck at Cristobal used by the cold storage plant. These trucks took the place of teams put out of service by the death of mules.

Animals died and destroyed during the year ending June 30, 1916, amounted to 37; animals surveyed and sold during the year, 3; and animals in corrals June 30, 1916, horses 118, mules 390, ponies 11; total, 519.

## MATERIAL AND SUPPLIES.

A total of 1,776 requisitions were prepared and forwarded to the general purchasing officer as compared with 1,428 during the preceding fiscal year. The total value of material received during the fiscal year was \$9,945,390.32, as compared with \$8,018,418.03 for the preceding fiscal year, the increase being largely due to the increased prices of materials. The local purchases amounted to \$1,569,812.15, as compared with \$1,360,469.71.

The total tonnage of material received was 404,569 short tons, exclusive of lumber, piling, spud timbers, etc., as compared with 211,000 tons for the preceding fiscal year.

The dredge *Cascadas*, contracted for in January, 1915, at a cost of \$376,180, was received and put into service. There were also received four wooden dump scows, at a price of \$30,000 each, two steel dump scows at a price of \$160,000 for the two, and the tug *Engineer* was taken over from the engineer department at large at a price of \$40,000.

There has been a general increase in the price of many of the staple articles of material, especially in iron and steel; the average price of steel and iron on hand on June 30, 1915, was \$1.63 per hundredweight, as compared with \$2.17 per hundredweight on June 30, 1916.

During the year The Panama Canal has had a contract with the Standard Oil Co. for delivery of fuel oil in bulk at Balboa, at a price of 92 cents per barrel, and a price of \$1.05 per barrel for oil delivered at Cristobal.

## OPERATION OF STORES.

All storehouse operations were placed under the supervision of a general storekeeper, and Mr. R. K. Morris was appointed to this position. The storehouse organization of June 30, 1916, consisted of the general storehouse at Balboa, the Paraiso storehouse, the obsolete store at Mount Hope, and the dry dock store at Cristobal.

On June 30, 1916, the value of material in stock was \$4,198,392.34, as against \$2,925,332.91 on June 30, 1915, not including the stock of obsolete and retired material and equipment on hand at the Mount Hope obsolete store. The increase in the value of the stock material on hand was due in a large measure to increase in the purchase price of a large number of items, as per the following statement:

	Dry dock store.	Paraiso store.	General storehouse.	Total.
On hand June 30, 1915.....	\$268,120.53	\$523,485.05	\$2,133,727.33	\$2,925,332.91
On hand June 30, 1916.....	356,221.92	759,047.12	3,083,123.30	4,198,392.34

The following statement shows the value of material issued from all storehouses during the year and the operation cost per \$100 issues:

	Dry dock store.	Paraiso. store.	General storehouse.	Total.
Issues.....	\$811,364.49	\$1,022,958.39	\$7,194,241.19	\$9,028,564.07
Pay roll.....	22,795.84	22,084.79	134,899.00	179,779.63
Operation cost per \$100 issues.....	2.81	2.15	1.87	1.99

On June 30, 1915, there was in stock at the forage shed 600,651 pounds of hay, 173,023 pounds of oats, and 40,779 pounds of straw, as against 816,608 pounds of hay, 483,054 pounds of oats, and 152,193 pounds of straw as of June 30, 1916; the increase in stock due to the protection of the requirements for the Army organizations, which had 1,108 animals on hand as of June 30, 1916.

During the year the consumption of cement amounted to 567,024 barrels.

Inspection, checking, and receiving Panama Canal material at Cristobal and Balboa was continued during the year under the supervision of the general storekeeper, during which period 8,356 cars and 2,767,630 packages and pieces were handled at an average cost of \$1.97 per car and \$0.0059 per piece and package.

During the year 296,135 local requisitions and foreman's orders were received and handled by the storehouses, as follows: General storehouse, Balboa, 182,750; Paraiso storehouse, 54,424; dry dock storehouse, 58,961.

Installation of a 2,000-gallon capacity gasoline tank near the oil house at Balboa, connected with a delivery pump on Dock No. 17, was completed September 15, 1915. This installation was made in order to provide for prompt and economical deliveries of gasoline to launches. During the year, 850 deliveries were made, totaling 50,853 gallons.

## SCRAP.

During the year the policy of concentrating at the obsolete storehouse at Mount Hope all surplus, obsolete, and scrap material and equipment was continued, and sales of this class of material continued to be made under authority of the sundry civil bill of March 3, 1915, and the Executive order of May 12, 1915.

The following statement shows American scrap operations at the obsolete store during the year:

	Net tons.
On hand June 30, 1915.....	27, 660
Received during the year.....	21, 249
Total.....	48, 909
Shipped to the United States.....	10, 156
Issued locally.....	5, 969
	16, 125
On hand June 30, 1916.....	32, 784

The following table shows the status of French scrap operations during the year:

	Gross tons.
On hand June 30, 1915.....	27, 063. 75
Applied on sales.....	283. 75
On hand June 30, 1916.....	26, 780. 00

The statement below shows receipts and issues in gross tons of scrap rail, scrap rail fittings, and relay rail during the year:

	Scrap rail.	Scrap fittings.	Relay rail.
On hand June 30, 1915.....	6,449. 00	326	126. 18
Receipts for year.....	5,968. 67	1,054	465. 00
Issued during year.....	12,467. 67	1,380	591. 18
	7,387. 00	915	18. 00
On hand June 30, 1916.....	5,080. 67	465	573. 18

Table No. 14 shows operations in scrap metals, rope, leather, and rubber at the obsolete store during the fiscal year.

During the year circular No. 927, listing 21,866 net tons of miscellaneous scrap and 6,000 gross tons of scrap rail, and circular 986, listing 15,010 net tons of miscellaneous scrap, were advertised in the United States and bids accepted in the following amounts:

*Circular 927.*

Federal Iron & Steel Co., Newark, N. J., 9,210 net tons miscellaneous scrap.....	\$31, 767. 56
The David Kaufman & Sons Co., Elizabethport, N. J., 6,000 gross tons scrap rail.....	48, 280. 00

*Circular 986.*

Federal Iron & Steel Co., 13,310 net tons miscellaneous scrap.....	\$78, 333. 98
The David Kaufman & Sons Co., 890 net tons miscellaneous scrap.....	4, 147. 20
M. Samuels & Sons Co., New York, 810 net tons miscellaneous scrap.....	3, 926. 50
Total.....	166, 455. 24

All of the material sold under circular 927 has been paid for in full by the purchasers, but a large part of it remains on the Isthmus. About 890 tons of the material under circular 986 has been paid for, but not removed from the Isthmus. The contractors are paying storage on all the material sold and not yet removed from the Isthmus.

The following statement shows status of American scrap on hand at the obsolete store as of June 30, 1916:

	Net tons.
Sold and due on circular 927.....	6, 475
Sold and due on circular 986.....	14, 200
Panama Railroad Company, scrap on hand.....	1, 734. 56
Panama Canal, scrap on hand.....	13, 843. 56
Total on hand.....	36, 253. 12

The status of scrap American rail and track material on hand at the obsolete store as of June 30, 1916, was as follows:

	Gross tons.
Sold and due on circular 927.....	1, 080
Panama Railroad Company, scrap on hand.....	1, 410. 67
Panama Canal, scrap on hand.....	2, 885. 67
Total on hand.....	5, 376. 34

The status of French scrap on hand at the obsolete store at the end of the fiscal year was as follows:

	Gross tons.
Sold and due on circular 927.....	185. 871
Sold and due on "Rovetta" contract.....	25, 000
Panama Canal, scrap on hand.....	1, 594. 129
Total on hand.....	26, 780

#### SALES.

During the year material to the value of \$220,116.40 was sold from storehouses to the United States Army organizations stationed on the Isthmus; the principal items sold consisting of forage, lumber, building material, and general hardware.

There was an increase in value of supplies sold to steamships in transit through the canal and those touching at the two terminals. The value of supplies sold to steamships was \$70,918.22, representing miscellaneous ship supplies sold to 860 steamers.

A total of 17,524 sales of all classes were made, total value of which amounted to \$436,079.80, as per the following statement:

	General.	Paraiso.	Dry dock.	Total.
Number of local sales.....	8, 984	1, 929	2, 079	12, 992
Number of sales to steamships.....	645		215	860
Number of credit sales.....	3, 240	6	426	3, 672
Total.....	12, 869	1, 935	2, 720	17, 524
Value local sales.....	\$96, 534. 31	\$3, 399. 60	\$22, 515. 63	\$122, 449. 54
Value sales to steamships.....	55, 337. 79		15, 580. 43	70, 918. 22
Value credit sales.....	210, 003. 81	70. 53	32, 637. 70	242, 712. 04
Total.....	361, 875. 91	3, 470. 13	70, 733. 76	436, 079. 80



During the year surplus and obsolete material with an appraised value of \$222,735.24 was forwarded to the United States for sale. Local credit and cash sales of obsolete material and equipment amounted to \$205,473.94, and obsolete material to the value of \$292,994.89 was issued and transferred from the obsolete store to divisions of The Panama Canal. There remained on hand at the obsolete store as of June 30, 1916, surplus and obsolete material with an appraised value of \$665,396.40.

## FUEL-OIL PLANTS AND STORAGE.

On September 1, 1915, the operation of the Balboa and Mount Hope fuel-oil plants was transferred from the mechanical division to the supply department, the personnel of the two plants being transferred to the organization of the general storekeeper at Balboa.

Construction of a trestle 1,200 feet long leading from the shore at the Balboa fuel-oil plant to the oil crib was completed February 14, 1916, at which time a new 12-inch crude-oil line was laid on the trestle from the plant to the crib. During the year the old 10-inch crude-oil line and the 6-inch Diesel line, which formerly were located under water, were taken up and relaid on the trestle.

Installation was completed during the year of two 10-inch crude-oil lines from Dock No. 13, Cristobal, across the canal to the new coaling station and an 8-inch line with 14 outlets was laid connecting into the 10-inch line around the coaling station, making it possible to handle two ships at the same time at the coaling station.

During the year erection of the following tanks on tank farms was completed:

## BALBOA.

	Number.	Capacity each.
		<i>Barrels.</i>
Panama Canal.....	1	55,000
Panama Canal Storage Corporation .....	2	55,000
West India Oil Co.....	1	25,000

## MOUNT HOPE.

		<i>Barrels.</i>
Panama Canal Storage Corporation .....	2	55,000
Huesteca Petroleum Co.....	2	55,000
Texas Oil Co.....	2	55,000

Erection was started but remained uncompleted June 30, 1916, on one 65,000-barrel capacity fuel-oil tank at Balboa for the West India Oil Co., and one 55,000-barrel capacity tank for The Panama Canal at Mount Hope.

Table No. 15 shows the fuel-oil storage facilities on the tank farms of The Panama Canal as of June 30, 1916.

During the year 2,256,119 barrels of fuel oil were handled through the Balboa and Mount Hope fuel-oil plants, as per Table No. 16.

## GASOLINE STORAGE.

Panama Canal gasoline storage tank No. 31, capacity 200,000 gallons, was completed December 9, at Balboa, and the first cargo of bulk gasoline, comprising 102,476 gallons, was received February 18, 1916. An additional cargo of 100,550 gallons bulk gasoline was received March 26, 1916, and delivered to tank No. 31. Installation of the "Martini Hueneker" system for protecting gasoline storage tank No. 31 at Balboa against accidental ignition of its contents was completed on June 28, 1916. This system provided for the maintenance of a blanket of inert noninflammable gas in the tank above the surface of the gasoline.

Panama Canal gasoline storage tank No. 27, at Mount Hope, capacity 200,000 gallons, was completed December 15, 1915. Up to the end of the fiscal year it had not been considered necessary to order a supply of bulk gasoline for the Atlantic end.

## SUBSISTENCE.

The supply department continued the operation of the Washington, Tivoli, and Aspinwall Hotels during the fiscal year, also of the line restaurants and of the laborers' messes. The Hotel Washington is owned and financially supported by the Panama Railroad Company. All of the remainder are entirely supported by The Panama Canal. The general method of administration was the same as that followed during the past. Capt. F. H. Smith, assistant chief quartermaster, has been in direct charge of the hotels.

During the year the revenues of the Tivoli and Washington showed an increase over 1914-15 of \$33,310.26. While some of this increase may have been due to the tourist traffic, it is believed that the larger part of it was due to the interest of American business men in Panama and South America, and from present indications it is believed that this element of the business will increase and that there will be a demand on the hotel facilities in the future for the accommodation of the representatives of American business enterprises.

During the fiscal year the experiment at the Hotel Aspinwall was continued, the attractions and accommodations being increased and the launch service being improved by the addition of a 50-passenger gasoline launch, the *Taboga*. Due to other attractions and to the improved living conditions on the Isthmus, the employees availed themselves so little of the opportunity that a net loss of \$4,554.09 was suffered, and on July 1, 1916, the Acting Governor approved a recommendation that the hotel be closed except during the dry season.

No appreciable change was made in the forms of any of the restaurants or hotels, except that at Corozal, where the community was vacated and turned over to the Army, the hotel was abandoned.

The net revenue for the year from restaurants and messes was \$661,017.90, a decrease of \$87,221.15 from last year, while the total cost of operations was \$648,565.39, a decrease of \$78,208.68, making a profit of \$12,452.51, a decrease of \$9,012.47 from last year. Had the charges for building repairs, fuel, light, etc., been made, a net loss of \$3,727.68 would have been shown. No charge for equip-

ment has been made, this charge being absorbed by allotments of The Panama Canal.

The ratio of supplies consumed to revenue was 0.81 per cent less than last year. The ratio of total cost of operation to revenue was 0.98 per cent more than last year, making the percentage of profit to revenue 0.98 per cent less than last year. The net expenses for salaries and wages was \$77,995.74, a decrease of \$18,050.33, making the proportion of net pay roll to revenue 11.80 per cent, or 1.03 per cent less than last year.

The above record for restaurants and messes includes the Aspinwall Hotel on Taboga Island.

During the year a complete plan for rebuilding the restaurants was drawn up and appropriations were asked for from Congress to carry out the scheme, this plan to substitute concrete and tile constructions with so-called sanitary equipment of glass and metal for the old frame structures, thus enabling the hotels even in the Tropics to be kept vermin proof and thoroughly sanitary. These restaurant buildings will be completed during the present fiscal year and will contribute very greatly to the contentment of the employees required to eat thereat. The cafeteria system has so completely met the conditions on the Canal Zone that it will be extended to the Ancon restaurant, which has heretofore been maintained solely on the a la carte basis.

The Tivoli Hotel showed a net profit of \$24,929.85, compared with a net loss of \$1,974.16 for last year. Had a charge been made for building repairs, a net profit of \$17,007.51 would have been shown.

#### MOUNT HOPE PRINTING PLANT.

The value of stock on hand at the close of the fiscal year was \$53,407.02, as against \$45,198.38 for the preceding fiscal year.

There were added to the equipment of the printing plant during the year five Chandler & Price platen presses, with motors for operating, and various other small items, to a total value of \$1,960.30, and unserviceable items to the value of \$592.24 were surveyed and disposed of, so that the total value of equipment on hand June 30, 1916, was \$37,897.57, as compared with \$36,529.51.

The following table shows the principal items of manufacture:

	Quantity.		Quantity.
Forms.....	28, 114, 260	Scratch pads.....	77, 261
Books.....	149, 992	Sheets ruled.....	72, 630
Sheets carbon.....	16, 700	Tags, assorted.....	1, 001, 600
Time-tables.....	25, 475	Canal Records.....	554, 649
Cards, guide, etc.....	313, 394	Binders.....	2, 767
Stamps and daters.....	2, 789	Programs.....	23, 565
Cardboards.....	67, 100	Press rollers.....	45
Sheets paper.....	2, 208, 749	Leather covers.....	1, 579
Badges.....	144	Monotype sorts, pounds.....	714
Desk pads.....	125		

The total value of material issued was \$78,115.24, as compared with \$83,111.94 for the preceding period. The total value of material used in manufacture was \$30,625.52, as compared with \$37,053.09 for the fiscal year ended June 30, 1915.

## OPERATIONS OF THE COMMISSARY BRANCH.

A grocery and cold-storage commissary was opened at Fort Randolph, Canal Zone, on May 22, 1916.

A silver department was opened in connection with the Ancon commissary on July 10, 1915.

Display ice boxes have been installed in all commissaries. Fresh meats are now cut in the presence of customers, and all cold-storage articles are sold to customers in the manner followed by markets in the United States.

The Balboa ice and refrigerating plant was completed. Ice plant was taken over by the commissary branch on June 1, 1916, and arrangements are being made to have all cold-storage supplies for delivery to residents in the Ancon-Balboa district put up in this plant.

The abattoir was enlarged, and a chicken-fattening house was constructed, which is being operated in connection with the abattoir. A total of 7,762 cattle were killed, 3,843,377 pounds of dressed beef being turned out, the total value of output being \$446,682.69.

The S. S. *Caribbean* was remodeled and put in commission as a cattle transport on June 1, 1916, and brings an average of 430 cattle per week from Colombia.

A new building for the manufacture of ice cream and storage and handling of milk and butter is under construction at Cristobal.

The report of the financial operations of the commissary branch and plantations will be included in the report of the auditor, The Panama Canal and local auditor, Panama Railroad Company, and further report on these and the plantations will be made by this department in the annual report to the President of the Panama Railroad Company.

Respectfully submitted.

W. R. GROVE,  
*Chief Quartermaster.*

Maj. Gen. GEO. W. GOETHALS, United States Army,  
*Governor, The Panama Canal, Balboa Heights, Canal Zone.*

TABLE No. 1.—*Force actually at work on June 21, 1916.*

Department or division.	Monthly.	(Silver employees' wages specified in United States currency.)										Total.		(Grand total.		
		Artisans.						Laborers.				Silver.	Gold.			
		Special.	22 cents.	18 cents.	15 cents.	12 cents.	1 Spe- cial.	16 cents.	13 cents.	10 cents.	7 cents.				5 cents.	
Operation and maintenance:																
Locks and office.....	491	.....	7	22	44	14	1	.....	19	42	.....	1	641	158	799	
Terminal construction.....	240	11	33	85	301	34	.....	12	73	71	2	1	863	166	1,029	
Building.....	98	.....	363	386	441	24	50	.....	170	201	3	5	1,741	178	1,919	
Electrical.....	71	.....	28	43	127	90	.....	.....	.....	11	.....	2	381	166	547	
Municipal engineering.....	326	.....	43	179	309	196	51	1	296	966	13	33	2,413	84	2,497	
Dredging.....	1,841	1	14	52	130	31	.....	4	97	48	2	.....	2,230	320	2,540	
Mechanical.....	139	8	75	138	628	607	.....	10	61	167	9	7	1,849	812	2,661	
Marine.....	199	.....	.....	.....	.....	.....	30	.....	.....	.....	.....	.....	229	64	293	
Fortification.....	58	1	25	43	87	7	13	1	89	69	.....	.....	393	57	450	
General construction.....	4	.....	.....	1	.....	.....	.....	2	8	158	1	.....	175	1	176	
Total.....	3,467	21	588	949	2,067	1,012	146	30	813	1,733	30	49	10,905	2,006	12,911	
Supply:																
Main office.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	9
Commissary.....	1,113	.....	4	19	17	12	479	2	.....	338	12	3	1,999	168	2,167	
Subsistence.....	387	.....	2	2	.....	2	.....	.....	.....	.....	.....	.....	393	17	410	
Quartermaster.....	829	83	64	61	59	.....	.....	12	235	803	.....	6	2,152	89	2,241	
Accounting.....	21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	21	199	220	
Health.....	381	.....	3	3	21	.....	16	.....	34	374	9	20	861	178	1,039	
Executive.....	122	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	122	408	530	
Panama R. R.....	409	73	59	164	392	218	977	24	447	506	5	14	3,288	333	3,621	
Contractors.....	34	16	5	44	81	.....	.....	.....	42	4	.....	3	229	85	314	
Grand total.....	6,763	193	725	1,242	2,637	1,244	1,618	68	1,571	3,758	56	95	19,970	3,492	23,462	

1 European.

1 European.

TABLE No. 2.—*Force reports by months, fiscal year 1915-16, including contractors' force.*

Year and month.	The Panama Canal.		Panama R. R. Co.		Contractors' forces.		Grand total.
	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	
1915.							
July.....	3,179	17,975	310	4,019	86	300	25,869
August.....	3,270	18,038	318	3,212	90	234	25,162
September.....	3,129	17,160	335	2,112	109	230	23,075
October.....	3,237	16,513	344	4,771	110	233	25,208
November.....	3,254	16,247	362	4,768	110	233	24,974
December.....	3,289	15,703	334	3,783	26	118	23,253
1916.							
January.....	3,191	15,413	327	4,379	28	155	23,493
February.....	3,174	16,544	342	4,565	48	121	24,784
March.....	3,077	16,965	330	4,354	38	105	24,869
April.....	3,065	16,034	289	4,016	7	97	22,508
May.....	3,150	15,155	342	3,834	113	335	22,929
June.....	3,063	15,764	329	3,751	85	235	23,227

TABLE No. 3.—*High and low force records, December, 1906, to June 30, 1916, by fiscal years.*

	The Panama Canal.			Panama R. R.	Total Panama Canal and Panama R. R.
	Gold.	Silver.	Total.	Gold and silver.	
1906.					
December.....	3,881	15,604	19,485	4,416	23,901
1907.					
October.....	4,992	20,836	25,828	6,139	31,967
January.....	4,033	16,987	21,020	4,796	25,816
1908.					
April.....	4,950	21,168	26,118	7,052	33,170
November.....	4,161	19,803	23,964	5,863	29,827
1909.					
October.....	4,376	23,411	27,787	7,618	35,495
January.....	4,295	20,583	24,878	6,393	31,271
1910.					
March.....	4,553	26,284	30,837	7,829	38,676
December.....	4,705	24,383	29,098	6,044	35,142
1911.					
December.....	4,420	25,439	29,859	7,967	37,826
June.....	4,292	21,795	26,087	6,603	32,690
1912.					
January.....	4,332	25,818	30,150	8,024	38,174
August.....	4,122	24,860	28,982	5,855	34,837
1913.					
August.....	4,087	30,918	35,005	4,957	39,962
December.....	3,744	23,209	26,953	5,195	32,148
1914.					
January.....	3,944	23,824	27,768	5,502	33,270
June.....	3,790	21,499	25,289	4,343	29,632
1915.					
July.....	4,198	22,846	27,044	5,314	32,358
February.....	3,088	17,023	20,111	2,978	23,089
1916.					
July.....	3,208	17,982	21,190	5,349	26,539
September.....	3,129	17,160	20,289	2,447	22,736

NOTE.—Figures do not include contractors' forces. If taken into consideration, the greatest working force ever reported was 44,733, on Mar. 26, 1913.

TABLE NO. 4.—*Occupants of Panama Canal and Panama Railroad quarters June 30, 1916.*

Place.	Gold.			Europeans.			West Indians.		
	Men.	Women.	Children.	Men.	Women.	Children.	Men.	Women.	Children.
Balboa <sup>1</sup> .....	937	337	314	<sup>2</sup> 89	11	19	<sup>3</sup> 1,319	486	680
Ancon.....	953	420	363	6			247	16	3
Corozal.....	29	15	6				99	18	12
Pedro Miguel <sup>4</sup> .....	247	121	144	7			<sup>5</sup> 387	123	153
Paraiso.....	320	79	90	46	5	15	562	115	159
Culebra <sup>6</sup> .....	21	13	10	2	1	7	<sup>7</sup> 380	255	300
Gamboa.....	38	5	12				160	33	40
Gatun.....	218	175	212	12	2	3	<sup>8</sup> 1,027	892	1,052
Cristobal <sup>9</sup> .....	955	335	410	72			<sup>9</sup> 1,984	258	485
Total.....	3,718	1,500	1,561	233	19	44	6,195	2,196	2,892

<sup>1</sup> Includes Taboga Island, Naos Island, and Palo Seco.<sup>2</sup> Includes 17 Asiatics.<sup>3</sup> Includes 18 American Negroes, 30 Colombians and Panamanians, and 2 Panamanians on the gold roll<sup>4</sup> Includes Miraflores and Red Tank.<sup>5</sup> Includes 43 Panamanians.<sup>6</sup> Includes Empire, Las Cascadas, and Bas Obispo.<sup>7</sup> Includes 14 Panamanians.<sup>8</sup> Includes Colon Beach and Colon Hospital.<sup>9</sup> Includes 14 East Indians, 15 colored American citizens, and 412 PanamaniansTABLE NO. 5.—*Applications for married quarters on file June 30, 1916.*

Ancon.....	379	(52)
Ancon Hospital.....	4	
Paraiso.....	189	(15)
Gatun.....	106	(11)
Cristobal.....	172	(36)
Total.....	850	(114)

NOTE.—The figures in parentheses show the number of applicants already occupying regular or non-housekeeping family quarters at stations other than those at which applications are filed.

TABLE NO. 6.—*Animals in corrals June 30, 1916.*

Stations.	American horses.	Native ponies.	Mules.	Police ponies.	Private animals.	Total.
Ancon-Balboa.....	24	9	204	10	27	274
Paraiso.....	12		33	5	3	53
Las Cascadas Farm.....			8			8
Gatun.....			25	3		28
Cristobal.....	16	<sup>1</sup> 68	120	1		205
Total.....	52	77	390	19	30	568

<sup>1</sup> 66 Commissary ponies.

TABLE No. 7.—Value of material received during the fiscal year 1915-16 on requisitions.

	1915							1916							Total.
	July.	August.	Septem-ber.	October.	Novem-ber.	Decem-ber.	January.	Febr-uary.	March.	April.	May.	June.			
Construction, operation, and main-tenance:															
Lock operation and maintenance	\$25,226.49	\$1,329.47	\$313.02	\$15,038.70	\$11,709.12	\$10,210.45	\$24,430.39	\$7,843.87	\$9,130.77	\$11,852.13	\$3,279.76	\$1,268.12	\$121,652.29		
Terminal construction	153,330.94	291,353.34	228,114.66	178,557.37	221,518.07	10,652.93	17,532.23	142,474.99	31,112.62	45,008.10	194,264.93	146,911.84	1,714,862.01		
Electrical division	13,957.09	25,905.03	49,632.35	16,976.77	38,806.22	29,563.81	13,264.53	28,625.58	9,873.97	40,620.14	33,555.77	21,793.17	322,196.46		
Dredging division	18,257.21	14,583.54	713,162.76	67,536.99	15,204.86	42,430.36	19,242.26	58,587.29	58,587.29	42,063.63	82,713.22	299,300.62	1,373,113.19		
Mechanical division	11,968.13	10,478.53	10,386.10	8,808.43	7,537.28	10,068.08	7,934.42	10,191.53	2,874.29	7,943.40	15,281.06	7,578.55	111,159.80		
Building division	16,640.00	16,790.22	37,606.09	7,086.17	24,737.94	22,155.48	14,134.38	21,592.87	17,753.69	17,325.36	22,455.40	16,291.51	234,127.11		
Municipal engineering division	15,971.93	3,800.46	534.31	9,714.57	3,888.44	3,051.90	1,149.38	1,149.38	10,087.24	2,416.91	19,388.09	7,944.53	84,108.43		
Fortifications	7,717.56	2,031.68	585.30	3,251.50	730.02	20,590.13	16,194.48	7,152.92	320.73	16,222.83	10,303.99	2,891.26	87,992.60		
Accounting department	68.50	.....	46.41	1,300.00	2,355.00	88.25	2,734.95	3,058.90	3,725.15	30.07	3,366.25	8,392.50	25,165.98		
Executive secretary	.....	.....	.....	361.24	.....	566.47	546.89	462.18	514.15	282.52	159.47	1,677.48	4,600.40		
Meteorology and hydrography	376.25	25.00	85.00	.....	946.23	150.25	26,584.10	16,073.15	1,797.70	6,357.97	7,164.19	412.15	67,709.43		
Depot commissary	3,257.45	1,300.60	759.26	.....	2,876.38	150.25	664.59	196.59	305.93	265.32	773.00	615.50	30,179.88		
Marine division	7,146.25	62.47	630.32	12,374.51	145.40	664.59	7,000.00	196.59	703,796.35	457,464.54	504,424.50	514,368.75	5,165,307.04		
Supply department (stock)	434,218.97	307,446.35	228,276.71	330,530.99	271,997.75	319,171.85	650,108.78	443,501.41	703,796.35	457,464.54	504,424.50	514,368.75	9,342,660.87		
Total	708,196.77	674,709.69	557,019.73	1,300,490.36	651,444.46	442,169.08	882,076.20	701,565.63	849,902.31	647,852.94	897,129.72	1,029,447.98	9,342,660.87		
Health department	1,052.42	13,017.06	539.19	1,928.91	6,382.02	9,491.89	8,768.67	4,914.81	18,927.28	8,661.57	9,702.81	5,227.96	15,320.07		
Civil government	1,854.12	2,869.49	767.23	5,383.85	416.86	280.41	1,101.68	1,303.72	92.75	224.99	705.39	304.52	500,944.79		
Panama Railroad Company	271,623.03	3,427.76	390.50	10,123.47	10,804.94	16,997.03	50,273.68	77,771.74	8,830.86	5,428.66	24,471.52	20,801.55	150,320.77		
Grand total	952,756.34	694,021.00	558,536.71	1,317,540.59	669,048.33	468,938.41	943,280.23	785,555.90	877,753.20	662,168.16	932,009.44	1,055,782.01	9,947,390.32		
Local purchases on the Isthmus:															
Coal purchased from Panama R. R. Company	38,100.78	36,480.02	39,440.02	38,824.05	52,282.74	44,328.23	43,098.10	44,146.90	43,185.02	35,582.40	38,580.82	28,708.89	482,758.57		
Miscellaneous purchases from Panama R. R. Company	1,676.86	3,202.30	1,403.82	1,085.10	790.50	1,964.67	1,993.97	2,258.05	3,533.55	5,589.97	5,171.82	3,205.75	31,876.36		
Subsistence supplies purchased from Panama R. R. commis-saries:															
Hotels	45,614.36	45,781.73	44,555.36	47,556.03	44,159.47	44,139.09	39,824.73	41,879.19	44,172.22	43,230.95	42,742.54	39,665.36	523,321.03		
Tivoli	5,719.75	5,564.40	5,410.80	6,359.69	6,176.25	7,887.20	6,504.44	9,825.50	8,269.09	7,111.55	6,296.75	5,130.45	80,256.05		
Dredging division	16,804.88	16,011.98	15,539.63	18,401.62	21,670.44	22,761.60	19,797.34	19,344.09	20,344.37	18,949.42	19,564.62	19,772.64	228,962.63		
Health department	11,464.57	9,489.05	9,516.51	10,327.48	9,929.98	12,369.02	8,997.58	9,722.98	11,031.28	10,123.05	10,080.01	10,309.17	123,300.68		
Crude oil purchased from the Union Oil Co.	16,320.35	81.05	31.57	6.39	.....	.....	.....	.....	.....	.....	.....	.....	16,439.34		
Miscellaneous purchases from local merchants	369.23	8,206.69	2,144.42	507.40	996.19	1,381.27	2,652.93	1,108.33	1,057.82	22,816.81	965.23	593.06	42,860.38		
Postage stamps	3.00	25.00	15.00	.....	.....	16.00	1.25	25.25	.....	14.00	30.00	29.00	232.40		
Ice	3,174.10	3,089.60	3,019.78	3,415.23	3,273.59	3,419.07	3,224.13	3,254.06	3,666.40	3,359.13	3,529.25	3,380.37	39,804.71		
Total local purchases on the Isthmus	139,247.86	127,931.82	121,113.40	126,497.99	139,279.16	135,206.24	126,094.47	131,624.35	135,282.85	146,777.28	126,962.04	110,794.69	1,569,812.15		



TABLE NO. 8.—*Freight statement, fiscal year 1915-16.*

Steamship lines.	Number of steamers.	General cargo.	Lumber b. f.	Ties.		Piling.	Total weight.	
				Pieces.	Feet, b. m.		Pounds.	Tons.
Panama R. R. Company	66	<sup>1</sup> 526, 924, 364	269, 707	.....	.....	.....	526, 924, 364	263, 462
Leyland Line	16	1, 028, 556	.....	.....	.....	.....	1, 028, 556	514
United Fruit Co., New York	107	28, 926, 121	86, 261	.....	.....	.....	28, 926, 121	14, 463
United Fruit Co., New Orleans	84	<sup>2</sup> 35, 058, 181	6, 976, 797	3, 171	228, 921	852	36, 570, 481	18, 285
Tramps—Atlantic	16	<sup>3</sup> 1, 224, 638	6, 326, 254	9, 929	469, 631	4, 070	8, 448, 888	4, 224
Tramps—Pacific	13	<sup>4</sup> 2, 504, 885	4, 270, 557	.....	.....	195	2, 851, 010	1, 425
Pacific Mail	11	43, 780	28, 658	.....	.....	.....	43, 780	22
New York & Pacific	12	<sup>5</sup> 12, 124	10, 540, 895	.....	.....	893	1, 597, 199	799
Luckenbach S. S. Line	21	11, 451, 090	50, 083	.....	.....	.....	11, 451, 090	5, 725
Standard Oil Co. tanks	9	194, 932, 395	.....	.....	.....	.....	194, 932, 395	97, 466
Panama R. R. colliers	7	14, 616	.....	.....	.....	.....	14, 616	7
Total	362	802, 120, 750	28, 549, 212	13, 100	698, 552	6, 010	812, 788, 500	406, 392

<sup>1</sup> Includes 211,222,400 pounds of cement, equal to 528,056 barrels.<sup>2</sup> Includes weight of piling, approximately 756 tons.<sup>3</sup> Includes weight of piling, approximately 3,612 tons.<sup>4</sup> Includes weight of piling, approximately 173 tons.<sup>5</sup> Includes weight of piling, approximately 793 tons.

NOTE.—Above statement includes no material delivered to The Panama Canal for contractors under awards providing for their handling and erection thereof on the Isthmus.

TABLE NO. 9.—*Important items of material purchased from inception of canal work, 1904, to June 30, 1916.*

Articles.	Quantity.	Value.
Barges	59	\$1, 926, 810.00
Boats, tug	12	910, 734.00
Brick, building, fire, and paving	.....	447, 745.39
Cableways	8	367, 445.90
Cars	4, 181	4, 655, 355.79
Cement	7, 475, 849 barrels	8, 575, 314.10
Compressors, air	31	173, 931.87
Cranes	113	1, 172, 144.81
Dredges	17	3, 185, 300.00
Drills, rock	725	288, 376.59
Drivers, pile	6	53, 966.00
Explosives:		
Dynamite	60, 885, 989 pounds	7, 352, 007.26
Other blasting supplies	.....	676, 368.55
Forage and corral supplies	.....	1, 203, 795.07
Furniture:		
Married quarters	.....	276, 430.74
Bachelor quarters	.....	147, 596.65
Hospital quarters	.....	76, 666.65
Laborers' quarters	.....	208, 809.00
	.....	709, 503.04
Live stock:		
Horses	.....	39, 712.50
Mules	.....	131, 939.44
Cows	.....	15, 666.02
	.....	187, 317.96
Locomotives:		
Steam	189	1, 942, 502.00
Electric towing	40	513, 680.00
Lumber	323, 568, 177 feet b. m.	8, 281, 578.76
Material for locks	.....	14, 487, 954.65
Piling	187, 917 pieces	2, 674, 445.93

TABLE NO. 9.—*Important items of material purchased from inception of canal work, 1904, to June 30, 1916—Continued.*

Articles.	Quantity.	Value.
Plants:		
Gatun hydroelectric station building and equipment.....		\$366,657.43
Power (3).....		366,523.97
Material handling (3).....		689,358.60
Rock crusher (4).....		200,164.68
Filtration (5).....		181,409.77
Pumping (3).....		61,513.73
Boiler (2).....		114,961.00
Hydraulic dredging (1).....		192,868.00
Steel foundry (1).....		458,831.39
		2,632,288.57
Rails, steel.....	63,232	1,979,963.35
Roofing, corrugated iron.....		618,499.34
Screening, wire.....		521,311.47
Shovels, steam.....	102	1,094,879.96
Spreaders, earth.....	26	139,687.00
Ties, cross and switch.....	2,344,663	2,023,061.04
Unloaders.....	29	158,839.00

TABLE NO. 10.—*Houses, apartments, and occupants, by districts, of gold and silver quarters, as of June 30, 1916.*

Districts.	Gold.		Silver.		Total.	
	Family.	Bachelor.	Family.	Bachelor.	Family.	Bachelor.
Ancon-Balboa:						
Houses occupied.....	210	49	56	31	266	80
Rooms or apartments.....	622	649	430	90	1,052	739
Number of occupants.....	1,950	1,374	1,640	1,144	3,590	2,518
Corozal:						
Houses occupied.....	5	5	1	4	6	9
Rooms or apartments.....	7	12	1	4	8	16
Number of occupants.....	20	30	4	125	24	155
Paraiso-Pedro Miguel-Gamboa:						
Houses occupied.....	126	26	148	529	274	555
Rooms or apartments.....	209	193	23	90	232	283
Number of occupants.....	672	428	1,696	1,083	2,368	1,511
Gatun:						
Houses occupied.....	60	6	111	5	171	11
Rooms or apartments.....	170	30	891	18	1,061	48
Number of occupants.....	552	53	2,845	136	3,397	189
Cristobal:						
Houses occupied.....	119	27	66	21	185	48
Rooms or apartments.....	311	355	339	21	650	376
Number of occupants.....	1,026	674	1,003	1,724	2,029	2,398
Total:						
Houses occupied.....	520	113	382	590	902	703
Rooms or apartments.....	1,319	1,239	1,684	223	3,003	1,462
Number of occupants.....	4,220	2,559	7,188	4,212	11,408	6,771

NOTE.—The above table includes 12 gold families living in box cars, and 23 apartments, housing 23 gold employees, in Culebra, Empire, Las Cascadas, and Bas Obispo.

TABLE NO. 11.—*Operation of Hotel Tivoli July 1, 1915, to June 30, 1916.*

Month.	Supplies consumed.	Salaries and wages.	Miscellaneous expenses.	Total cost of operation.	Revenue.	Profit.	Loss.	Meals served.
<b>1915.</b>								
July.....	\$5,492.39	\$3,004.41	\$2,129.86	\$10,626.66	\$10,833.20	\$206.54		7,903
August.....	5,517.06	2,942.17	2,331.94	10,791.17	10,784.95		\$6.22	8,809
September.....	5,007.21	2,906.16	2,657.08	10,570.45	10,198.30		372.15	8,077
October.....	6,227.88	2,902.39	2,072.07	11,202.34	14,591.25	3,388.91		10,894
November.....	6,054.17	2,925.96	1,858.35	10,838.48	12,972.31	2,133.83		10,326
December.....	6,652.90	3,171.41	2,633.68	12,457.99	15,098.15	2,640.16		11,037
<b>1916.</b>								
January.....	6,771.73	3,230.78	2,861.36	12,863.87	15,326.25	2,462.38		11,922
February.....	9,540.82	3,653.18	2,861.62	16,055.62	24,076.00	8,020.38		17,599
March.....	8,456.15	3,430.91	2,716.86	14,603.92	19,341.10	4,737.18		14,166
April.....	6,962.86	3,016.43	2,399.54	12,378.83	15,102.70	2,723.87		11,214
May.....	6,257.86	2,894.69	2,778.33	11,930.88	12,203.80	272.92		9,368
June.....	4,779.77	2,569.24	2,407.11	9,756.12	8,478.17		1,277.95	6,165
Total.....	77,720.80	36,647.73	29,707.80	144,076.33	169,006.18	26,586.17	1,656.32	127,430

Net, \$24,929.85

TABLE NO. 12.—*Summary of operations of line hotels July 1, 1915, to June 30, 1916.*

Month.	Supplies consumed.	Salaries and wages.	Miscellaneous expenses.	Total cost of operation.	Revenue.	Profit.	Loss.
<b>1915.</b>							
July.....	\$34,577.73	\$5,748.23	\$2,958.93	\$43,284.89	\$43,034.60		\$250.29
August.....	37,013.56	6,044.60	2,822.96	46,481.12	45,594.90		886.22
September.....	36,477.67	6,164.72	2,925.63	45,568.02	44,871.04		696.98
October.....	36,910.22	5,942.54	2,907.11	45,759.87	44,544.27		1,215.60
November.....	35,566.48	6,017.41	3,493.87	45,077.76	42,615.81		2,461.95
December.....	33,297.47	5,633.92	3,787.71	42,719.10	41,624.72		1,094.38
<b>1916.</b>							
January.....	33,951.05	5,236.72	4,095.51	43,283.28	43,229.06		54.22
February.....	33,309.10	5,430.99	3,910.49	42,650.58	42,612.95		37.63
March.....	35,221.39	5,035.93	4,038.01	44,295.33	45,699.77	\$1,404.44	
April.....	37,763.89	5,306.92	4,203.72	47,274.53	44,048.59	772.66	
May.....	33,889.15	5,165.92	4,020.35	43,075.42	42,023.00		1,052.42
June.....	29,965.48	4,519.69	3,831.57	38,316.74	38,826.21	209.47	
Total.....	414,543.19	66,547.59	42,995.86	524,086.64	518,722.92	2,385.97	7,749.69

Loss..... \$5,363.72  
 Charges against line hotels for fuel, light, and repairs to buildings, etc..... 16,180.19

Profit on messes (see Table No. 13)..... 21,543.91  
 17,816.23

Net loss on laborers' messes and line hotels if charges for fuel, light, and repairs to buildings, etc., had been made..... 3,727.68

TABLE NO. 13.—*Summary of operations laborers' messes, July 1, 1915, to June 30, 1916.*

Month.	Supplies consumed.	Salaries and wages.	Miscellaneous expenses.	Total cost of operations.	Revenue.	Profit.	Rations served.
<b>1915.</b>							
July.....	\$10,030.55	\$995.46	\$532.54	\$11,558.55	\$12,627.79	\$1,069.24	31,252
August.....	8,468.93	940.51	462.71	9,872.15	11,182.69	1,310.54	27,932
September.....	7,879.44	907.64	476.16	9,263.24	10,134.74	871.50	25,337
October.....	9,486.02	989.32	361.85	10,837.19	12,326.17	1,488.98	30,815
November.....	9,052.05	1,006.77	776.63	10,835.45	11,952.24	1,116.79	29,880
December.....	6,977.26	892.82	749.22	8,619.30	8,894.12	274.82	22,235
<b>1916.</b>							
January.....	8,611.64	931.38	624.24	10,167.26	12,121.01	1,953.75	30,343
February.....	8,335.22	994.99	625.89	10,014.10	11,576.77	1,562.67	28,967
March.....	9,332.29	923.98	591.68	10,847.95	13,058.24	2,210.29	28,252
April.....	8,825.30	969.14	519.53	10,313.97	12,267.68	1,953.71	27,609
May.....	9,625.66	951.48	578.99	11,156.13	12,487.55	1,331.42	27,685
June.....	9,480.79	944.71	567.96	10,993.46	13,665.98	2,672.52	30,754
Total.....	106,163.15	11,448.20	6,867.40	124,478.75	142,294.98	17,816.23	341,061

TABLE NO. 14.—*Obsolete storehouse operations in scrap metals, rope, leather, and rubber, fiscal year 1915-16.*

Items.	On hand July 1, 1915.	Receipts, 1915-16.	Issued and sold 1915-16.	Balance, June 30, 1916.
Brass:				
Weight .....	11, 833	197, 780	173, 532	36, 081
Value .....	\$1, 419. 96	\$23, 733. 60	\$20, 823. 84	\$4, 329. 72
Copper:				
Weight .....	9, 931	156, 933	103, 639	63, 225
Value .....	\$1, 787. 58	\$8, 247. 94	\$18, 655. 02	\$11, 380. 50
Lead:				
Weight .....	36, 587	48, 080	56, 068	28, 609
Value .....	\$1, 646. 42	\$2, 164. 06	\$2, 523. 06	\$1, 287. 41
Zinc:				
Weight .....	1, 778	11, 695	13, 473	.....
Value .....	\$213. 36	\$1, 403. 40	\$1, 616. 76	.....
Rubber:				
Weight .....	44, 519	89, 139	120, 334	13, 324
Value .....	\$445. 19	\$891. 39	\$1, 203. 34	\$133. 24
Rope:				
Weight .....	226, 652	118, 693	128, 402	16, 943
Value .....	\$666. 30	\$5, 793. 93	\$3, 210. 05	\$423. 58
Leather:				
Weight .....	4, 421	588	3, 939	1, 070
Value .....	\$110. 53	\$14. 70	\$98. 48	\$26. 75

NOTE.—The value of scrap as listed above is figured on the basis of upset prices established on the Isthmus.

TABLE NO. 15.—*Fuel-oil storage facilities on the tank farms of The Panama Canal as of June 30, 1916.*

## BALBOA.

	Number tanks.	Capacity in barrels, each.	Total capacity
The Panama Canal .....	2	42, 000	84, 000
Do. ....	1	55, 000	55, 000
Do. ....	1	5, 000	5, 000
Panama Canal Storage Corporation .....	2	55, 000	110, 000
Union Oil Co. ....	4	35, 000	142, 000
Panama Agencies Co. ....	1	25, 000	25, 000
West India Oil Co. ....	1	25, 000	25, 000

## MOUNT HOPE.

The Panama Canal .....	2	42, 000	84, 000
Panama Canal Storage Corporation .....	2	55, 000	110, 000
Huestee Petroleum Co. ....	2	55, 000	110, 000
Texas Oil Co. ....	2	55, 000	110, 000
Total storage facilities .....	.....	.....	860, 000

TABLE NO. 16.—*Fuel oil handled by The Panama Canal, fiscal year 1915-16.*

	Balboa.	Mount Hope.	Total.
Number of barrels received by The Panama Canal .....	579, 389	97, 108	676, 497
Number of barrels used by The Panama Canal .....	517, 191	108, 746	625, 937
Number of barrels pumped for individuals and companies <sup>1</sup> .....	800, 587	92, 578	893, 165
Number of barrels sold by the Panama Canal .....	48, 427	12, 093	60, 520
Total number of barrels handled .....	1, 945, 594	310, 525	2, 256, 119
Total number of ships handled .....	262	48	310

<sup>1</sup> Quantity shown pumped for individuals and companies includes amount of oil pumped into storage tanks and amount delivered from tanks.

## APPENDIX H.

### REPORT OF THE AUDITOR IN CHARGE OF THE ACCOUNTING DEPARTMENT.

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BALBOA HEIGHTS, CANAL ZONE,  
*September 1, 1916.*

SIR: I have the honor to submit the following report of the transactions of the accounting department for the fiscal year ending June 30, 1916:

#### ORGANIZATION.

The organization of the department has continued substantially unchanged as set forth in the annual report for 1915. The division of auditing and accounting is under the immediate direction of the auditor and the division of disbursement under the paymaster, Mr. John H. McLean, and the division of collections under the collector, Mr. T. L. Clear. Judge B. F. Harrah has resumed charge of the office of the department in the United States after completing his temporary assignment as special counsel and examiner of claims to investigate the claims of the McClintic-Marshall Construction Co. Mr. Virgil C. Miller has continued as disbursing clerk in the Washington office. Mr. Ad Faure, chief accountant, has continued in charge of the accounting bureau, Mr. Elwyn Greene of the auditing bureau, Mr. J. H. Helmer of the claims bureau, Mr. W. H. Kromer of the railroad accounting bureau, and Mr. Herbert Pearson of the bureau of traveling inspection of the auditor's office.

#### PAYMASTER.

Disbursements to the amount of \$26,933,528.35 were made during the year by the paymaster. Of this amount the sum of \$8,694,110.12 was on account of the Panama Railroad Company. The sum of \$5,983,624.10 was paid to employees on the gold rolls and \$5,821,753.09 to employees on the silver rolls of The Panama Canal, while the sum of \$6,434,041.04 was paid on miscellaneous vouchers. (See Table No. 34.) Collections made on pay rolls, mainly on account of coupon books and meal tickets, amounted to \$2,709,743.60. Of this amount \$2,556,093.08 were disbursed directly by the paymaster and the balance, \$153,650.52, was transferred to the collector's accounts. The Commercial National Bank, Washington, D. C. (Panama branch), was made a Government depository as well as a fiscal agent. A small deposit of Government funds is now carried in this bank.

## COLLECTOR.

The collections made during the year and repaid to appropriations amounted to \$7,220,622.65. The sum of \$2,756,764.83 was collected and deposited as Miscellaneous receipts. Of these amounts a very small proportion was received by the disbursing clerk in Washington and not by the collector. Deposits for the payment of tolls and bills for supplies and services were made with the assistant treasurers of the United States to the credit of the collector in the sum of \$2,146,755.14. Similar deposits were made direct with the collector on the Isthmus in the sum of \$3,386,117.92. Of the total, \$5,532,873.06, the sum of \$541,014.95 was refunded upon settlement of accounts. Money-order funds to the amount of \$2,365,799.83 were transferred to the Postmaster General of the United States in payment of money orders drawn on the United States. Other disbursements of miscellaneous funds to the amount of \$200,683.03 were made by the collector. (See Tables 34 to 36.)

## ACCOUNTING TO THE TREASURY FOR COLLECTIONS.

Under the provisions of section 3 of the sundry civil act of March 3, 1915, the Comptroller of the Treasury has detailed employees, one from the Office of the Auditor for the War Department and the other from the Office of the Comptroller of the Treasury, to make the required semiannual examination of the collection accounts on the Isthmus. At the present time employees from these offices are making the examinations for the period ending June 30, 1916.

## CLAIMS FOR REFUND OF TOLLS.

In my last annual report I mentioned the number of claims that have been filed for refund of tolls, due to the ruling of the Attorney General that the tolls collected under the Panama Canal rules for measurement must not exceed \$1.25 per ton, as determined in accordance with United States statutes relating to net registered tonnage. An estimate for approximately \$300,000 was submitted to Congress for inclusion in the sundry civil bill, but was eliminated by that body. It is recommended that the authority to refund these tolls be requested in connection with the next estimates for appropriations. The tolls on vessels transiting the canal during the year have amounted to \$2,399,830.42. The United States net registered tonnage of these vessels was 1,997,741 tons, the tonnage under Panama Canal rules 2,479,762 tons. The collections would have amounted to \$2,790,544.47 had the Panama Canal rules only been applied, a loss to the canal of \$390,714.05. Vessels under foreign registry are the beneficiaries. See Tables 67 and 67a, containing a list of vessels passing through the canal, the tolls collected, the United States registered tonnage, the Panama Canal tonnage and the amount that would have been collected under the Panama Canal rules of measurement.

## CLAIMS FOR DAMAGES TO VESSELS PASSING THROUGH THE LOCKS.

A number of small claims for damages to vessels passing through the locks have been made in accordance with the provisions of section five of the Panama Canal act; also a few claims for damages arising

in the canal and harbors. The sum of \$1,578.65 has been paid in settlement of 13 claims. Up to the present time it has been possible to adjust and settle by mutual agreement all claims of this character which have been presented without recourse to the courts, as authorized by the Panama Canal act.

#### EXAMINATION OF PAY ROLLS.

As mentioned in several previous annual reports, the work of checking pay rolls under the provisions contained in the legislative, executive, and judicial appropriation act, approved August 23, 1912, "That disbursing officers shall make only such examination of vouchers as may be necessary to ascertain whether they represent legal claims against the United States," has continued very satisfactorily.

#### CANAL APPROPRIATIONS.

Congress has appropriated for the canal and the fortification thereof a total of \$415,985,149.02, including the appropriations made July 1, 1916. Of this amount \$19,224,873.30 were for fortifications; \$1,000,000 to cover the four annual payments of \$250,000 each to the Republic of Panama for Canal Zone rights and \$6,000 for the expense of presenting the steam launch *Louise* to the French Government. The sum of \$7,050,000 was appropriated for operation and maintenance, sanitation, and civil government of the canal and the Canal Zone for the fiscal year, 1917, \$6,440,000 for the fiscal year 1916, while \$4,289,159 were charged against the operation and maintenance of the canal to the end of the fiscal year 1915.

Of the amount of the value of material in quartermaster's storehouses June 30, 1915 (\$3,284,244.35), and paid for out of construction appropriations, it was estimated last year that \$2,225,000 would be required for the permanent stock of material and supplies, etc., for the operation and maintenance of the canal. It is evident that this was too low an estimate and that it would have been entirely proper to have used the sum of \$3,000,000 for this purpose and to have deducted that amount from the charges against the authorized bond issue. However, it has been determined to use the amount as first fixed as the maximum amount to be charged against the operation and maintenance of the canal under the provisions of section 7 of the sundry civil act approved August 1, 1914, authorizing the consolidation of various canal appropriations other than fortifications, and accounting for the balances thereof as determined by the Governor of The Panama Canal.

Deducting from the total appropriations the amount appropriated for fortifications (\$19,224,873.30) for Panama \$1,000,000, for presenting the launch *Louise* \$6,000, for operation and maintenance \$20,004,159, including the amount for stock of material and supplies, leaves \$375,750,116.72 appropriated for the construction of the canal and its immediate adjuncts. Of this amount \$3,400,000 appropriated for colliers, \$800,000 for Dock No. 6, Cristobal, and \$600,000 for re-boiling the steamships *Ancon* and *Cristobal*, were specifically exempted by law as a charge against the authorized bond issue, so that the net amount chargeable to the bond issue of \$375,200,900 is \$370,950,116.72, leaving a balance of \$4,250,783.28 available for

appropriation within the limit of cost of the canal and the authorized bond issue.

Miscellaneous receipts to June 30, 1916, amounted to \$13,736,-665.95. Deducting the amount received as tolls (\$6,757,832.79) and the Canal Zone revenues for the year 1916 (\$146,689.02), gives the amount repaid as the cost of construction \$6,832,144.14. The sum of \$4,723,805.99 was received for material sold, services rendered, etc. Deducting the amount repaid leaves the sum of \$364,117,972.58 as the amount expended, or on hand for immediate expenditure for projects included within the estimate upon which the cost of the canal was based. The ultimate cost of the canal will be further reduced by receipts from the sale of construction material and equipment and by the payments to be made by the Republic of Panama for the amount expended on account of water-works, sewers, and pavements in the cities of Panama and Colon. The cost of the canal as a commercial venture is also entitled to credit to the value of buildings and other public works, equipment, and plant transferred to the Army, the Alaskan Engineering Commission, and the State Department, without any actual payment therefor. The estimated value of items transferred is \$1,755,978.80. (See Tables Nos. 1 and 11.) The status of the authorized bond issue is shown in Table No. 1. The general balance sheet is published as Table No. 2.

#### EXCHANGE OF PROPERTY WITH PANAMA RAILROAD.

There are two items of loans standing against the Panama Railroad Company, one a loan to enable the company to reequip its line, \$1,399,114.61, the other to enable the company to take up its first-mortgage bonds, \$1,848,217.50, a total of \$3,247,332.11. By section 2 of act of Congress of March 4, 1911, it was provided that the company should not make any further payment on the principal or interest on the notes given to the United States for moneys appropriated for its use. As a result the company has been enabled to construct docks in Cristobal to a value which about equals the amount of the loans. There is also considerable equipment purchased and paid for by The Panama Canal which is required in connection with the operation of the railroad. The steamships *Panama*, *Colon*, *Ancon*, and *Cristobal* were purchased from canal appropriations and are operated by the Panama Railroad. It is essential, in order to simplify the transactions between the two interests, that an exchange should be made. A provision authorizing this was included in the estimates for the fiscal year 1917, but same did not become a law. It is recommended that a similar provision be inserted in the estimates for 1918 and that every effort be made to effect the exchange and the cancellation of the loans. The railroad would own all equipment used in railroad operations, also all steamships it operates other than the colliers, and the United States would own directly the dock and other terminal facilities at both ends of the canal, and all outstanding accounts would be settled.

Under the agreement with the Republic of Panama, which requires the reimbursement of the United States for expenditures connected with the construction, operation, and maintenance of water-works, sewers, and pavements in the cities of Colon and Panama, the expenditures to June 30, 1916, in Panama were \$1,995,920.84, and in



Colon \$1,857,655.31, a total of \$3,853,576.15, including accrued interest to date at the rate of 2 per cent per annum on the capital cost balances and on the proportionate cost of waterworks in the Canal Zone used for supplying water to the two cities, based upon the quantity of water consumed. For the work in Panama this interest has amounted to \$211,967.58, and for the work in Colon \$168,121.16, and for the proportionate cost of waterworks in the Canal Zone \$67,832.62, a total of \$447,921.36. There have been reimbursed to the United States, or are immediately due, \$1,789,895.11, leaving a balance of \$1,046,135.60 due for the work in Panama and \$1,017,545.44 for the work in Colon, a total of \$2,063,681.04 payable in installments during the next 44 years. The amount which is payable immediately under the agreement is \$58,616.55, and is covered by bills for the differences between the current charges for the work plus the quarterly payments required and the amount collected as water rentals.

## CONSTRUCTION OF CANAL.

[TABLE NO. 3.]

During the fiscal year just ended there were classified as construction of canal \$8,844,125.26, which amount included \$681,278.58 for overhead expenses, leaving \$8,162,846.68 directly charged by divisions. The principal items comprised in this charge were: Dredging in canal prism at the Atlantic entrance \$2,744.52, 20,746 cubic yards being removed at an average cost of \$0.1323 per cubic yard. (See Table No. 25A.) Colon east breakwater \$1,238,611.68, the principal items entering into this expense being: Trestle construction \$88,821.54, consisting of 1,866 linear feet of double track trestle at an average cost of \$47.6000 per linear foot; trestle reconstruction \$101,223.83, consisting of 5,606 linear feet of single track trestle at an average cost of \$18.0563 per linear foot; dry filling \$427,661.70, covering the quarrying and plowing off of Lidgerwood cars of 428,383 cubic yards of Sosa Hill rock at an average cost of \$0.9983 per cubic yard; hydraulic filling \$165,330.54, including \$60,884.90 for 215,644 cubic yards of spoil placed in the fill for trestle reconstruction at an average cost of \$0.2823 per cubic yard; and placing concrete blocks \$440,575.43, being 115,432.5 cubic yards of blocks manufactured and placed at an average cost of \$3.8167 per cubic yard. For further detail reference is made to Table No. 17.

Dredging from Gatun to Pedro Miguel, \$104,738.79 includes 264,850 cubic yards of material removed at an average cost of \$0.3470 per cubic yard. (See Table No. 25B.)

From Pedro Miguel to the sea there were expended \$116,520.57 mainly in drilling and blasting. In this section 18,602 cubic yards of material were removed from Miraflores Lake at an average cost of \$0.2734 per cubic yard, and 48,124 cubic yards between Miraflores Locks and the sea at an average cost of \$0.2261 per cubic yard (see Table No. 25c), this high cost being due to drilling and blasting areas to be dredged at a later date. (See Table No. 25d.)

There were expended for aids to navigation \$43,828.20, the principal items entering into this expense being: Punta Mala light, \$19,048.63; Bona Island light, \$2,974.52; Taboguilla light, \$3,601.76; mooring station at Paraiso, \$3,519.30; and observation station on

Sosa Hill, \$5,214.56. For further detail, reference is made to Table No. 18.

There were expended for the power producing and transmitting system \$122,666.96, principally for the removal of generating units from Gatun to Miraflores and for the extension of the Miraflores power house.

In continuing the construction of the Atlantic terminal \$1,551,-747.62 were expended for the Cristobal coaling plant, the principal items entering into this expense being: Preliminary and general work, \$51,297.45; dredging, \$262,889.39, covering the removal of 721,609 cubic yards of material at an average cost of \$0.3643 per cubic yard; caisson construction for foundations, \$99,398.57; floor, \$129,957.98, in the construction of which 10,634 cubic yards of concrete were placed at an average cost of \$4.7088 per cubic yard; superstructure, including the stocking and reclaiming bridges, unloader and reloader towers, and the conveyor system, \$921,080.83; fender system, \$26,483.27; and office and machine shop, \$20,895.06.

There were expended \$42,771.88 in the construction of the fuel oil plant at that point, the principal items being: Preliminary work in connection with tank No. 9, \$2,244.42; oil pump plant, \$4,677.61; pipe lines, \$22,747.41; and gasoline storage, \$12,630.48. For further detail reference is made to Table No. 19.

At the Pacific terminal \$3,062,379.61 were expended for the following projects: Preparatory work, \$78,301.90. Dredging inner harbor, \$322,593.76, involving the removal of 1,839,594 cubic yards of material by dredges at an average cost of \$0.1573 per cubic yard, and the pumping of 726,230 cubic yards of spoil in connection with the reclamation of land at an average cost of \$0.0456 per cubic yard. Main dry dock, \$953,332.82, the principal items being: Preliminary and general work, \$53,589.86; preparing foundations, \$11,781.38 consisting of the excavation of 6,059 cubic yards of material at an average cost of \$1.9444 per cubic yard; mass and reinforced concrete, \$72,070.75 and \$137,316.80, respectively, consisting of 12,897 and 17,757 cubic yards, respectively, placed at an average cost per cubic yard of \$5.5882, and \$7.7331, respectively; granite, \$21,362.71; erection of gates, \$114,383.23; back filling, \$44,729.76, consisting of the placing of 52,993 cubic yards of material at an average cost of \$0.8403 per cubic yard; installation of miscellaneous machinery, piping for air, water, and sewerage, and electrical and general ironwork, \$223,175.95; and entrance pier, \$126,696.60.

Coaling station, \$920,226.68, the principal items being: Preliminary and general work, \$10,910.66; coal handling plant, \$504,290.35—\$365,275.45 of which represents payments to contractors and \$37,555.09 the placing of 4,848 cubic yards of concrete at an average cost of \$7.7465 per cubic yard; sea wall and unloader wharf, \$121,070.28—\$25,617.61 of which covers the placing of 4,835 cubic yards of mass concrete at \$5.2984 per cubic yard; and the reloader wharf, \$224,562.36—\$17,608.63 of which represents preliminary and general work; \$84,608.79, the substructure in the caisson cylinders—of which 5,982 cubic yards of reinforced concrete were placed at an average cost of \$7.2854 per cubic yard, or a total cost of \$43,581.30.

Balboa shops, \$232,418.97, the principal items being: General work, \$79,047.61; planing mill, \$15,922.80; main office, \$33,011.53; compressor plant and pump house, \$101,201.73; and shop tunnel, \$9,682.92.

Quay walls and pier, \$448,219.52, principally for the continuation of construction of Pier No. 18.

Fuel oil plant, \$58,068.42, the principal items being: Tank No. 5, \$10,604.03; tank form, \$10,273.52; pipe lines, \$18,811.83; and gasoline storage, \$11,409.38. For further detail reference is made to Table No. 20.

For permanent townsites there were expended \$278,011.34, principally in the construction of roads, sewers, and water lines in the Ancon-Balboa district. For further details reference is made to Table No. 21.

For permanent buildings there were expended \$1,019,089.82, the principal items and their cost being: Gold quarters, \$399,111.03, including \$151,794.58 for four-family concrete houses; \$69,139.25 for concrete bachelor quarters; and \$152,790.73 for wooden quarters; silver wooden quarters, \$42,330.37; hospitals, \$346,454.58, consisting of \$165,653.88 for Colon hospital and \$180,800.70 for Ancon hospital; Balboa quarantine station and landing, \$15,914.04; and Balboa terminal office building, \$70,594.76. For further detail reference is made to Table No. 22.

At Mount Hope \$22,089.62 were expended for sanitary filling.

For construction of roads, not included in townsites, there were expended \$76,877.03.

There were charged to real estate for depopulation of the Canal Zone \$379,345.25, being awards of the Joint Land Commission and settlements made by the land office.

#### MANUFACTURING PLANTS.

During the fiscal year just ended 579,148 cubic yards of sand and gravel were reclaimed from the Chagres River at an average cost of \$0.5179 per cubic yard. (See Table No. 27.)

The Gatun hydroelectric plant and the Miraflores steam electric power plant generated 34,186,761 kilowatt hours during the past fiscal year at an average production cost of \$0.0049 per k. w. hour. The distributed cost was \$0.0077 per k. w. hour. Included in the above cost is a charge for depreciation of the power transmission system of \$96,000, or \$0.0028 per k. w. hour. (See Table No. 28.)

The Ancon-Balboa-Panama waterworks system produced 2,357,-832,000 gallons of water at an average cost of \$0.0587 per thousand gallons. Of this amount 936,999,000 were used in the city of Panama. The Gatun system produced 251,797,000 gallons of water at an average cost of \$0.1792 per thousand gallons. The Colon-Cristobal system produced 1,428,020,000 gallons at an average cost of \$0.0639 per thousand gallons. Of this amount 674,064,000 gallons were used in the city of Colon. (See Tables Nos. 29 to 31.)

## OPERATION AND MAINTENANCE.

[TABLE NO. 6.]

During the fiscal year 1916 there were expended in the operation and maintenance of The Panama Canal \$6,999,750.15, as against \$4,123,128.09 last year. The main item of expense was \$3,513,350.06 for dredging 12,430,209 cubic yards of material from the slides in Gaillard Cut at an average cost of \$0.2806 per cubic yard, while last year there were expended for dredging in this area \$1,633,030.06 for the removal of 4,710,566 cubic yards of material at an average cost of \$0.3467 per cubic yard. For detailed costs, see Table No. 26B.

The expense for maintenance of machinery and equipment at the various locks shows increase over last year of \$110,607.85, due principally to painting the gates and valves with bitumastic enamel, while the total expense of operation and maintenance of the locks shows a decrease of \$13,876.21. Charges to operation and maintenance for overhead expenses were \$2,449,590.82 this year, as against \$1,380,405.53 last year, this increase being wholly due to a different method in allotting overhead expenses, which was explained in the annual report for last year.

Tolls collected during the fiscal year 1916 amounted to \$2,399,830.42, as against \$4,343,383.69 last year, the decrease being due to the closing of the canal by slides from September 18, 1915, to April 15, 1916. Business operations show a profit this year of \$11,898.44 (see Table No. 7), as against a loss last year of \$56,400.78. There is a deficit in the operation and maintenance of the canal of \$4,588,021.29 this year, as against a profit last year of \$220,255.60.

## OVERHEAD EXPENSES.

[TABLE NO. 5.]

Overhead and general expenses include the expenses of general administration, civil government, health department, supply department, accounting department, etc., and during the past fiscal year have amounted to a total of \$4,549,099.62, as against \$4,389,264.41 for the year 1915, an increase of \$159,835.21. Of this amount \$1,015,000.13 were charged directly to other interests during the year 1916, as against \$786,942.21 during the year 1915, leaving a net amount to be distributed amongst the various activities of the canal of \$3,534,099.49 in 1916, as against \$3,602,322.20 in 1915.

The expenses of the executive office were \$439,204.95 this year, as against \$521,916.88 last year, a decrease of \$82,711.93, of which \$64,613.34 is due to change of classification, whereby the expenses of the office of the engineer of maintenance are shown as a separate item this year. The expenses for civil government were \$545,271.10 this year, as against \$434,137.42 last year, an increase of \$111,133.68, which is wholly due to payments from congressional appropriations of the expense for schools, magistrates courts, and a portion of the post-office expenses, which were formerly paid from the revenue of the Canal Zone.

The gross expenses of the health department were \$942,310.44 this year, as against \$923,234.25 last year, practically no fluctuation having occurred. For detailed costs, reference is made to Table No. 24.

The expenses of the supply department were \$1,007,950.52 this year, as against \$927,781.89 last year, an increase of \$80,168.63,

mainly due to increase in the expenses for operation and repairs to quarters, \$106,924.21, partially offset by the decrease in expense of operation of storehouses, \$39,065.18. Maintenance and care of the administration building and handling freight on docks show a small decrease.

The expenses of the accounting department, including the Washington office, were \$468,967.81 this year, as against \$452,464.24 last year. The services rendered the Panama Railroad Company this year amounted to \$136,118.24, as against \$90,053.02 last year, an increase of \$46,065.22. Deducting these amounts from the gross expenses of the department shows a saving during this year, as compared with last year, of \$29,561.65.

There is a decrease in the expense for recruiting and repatriating employees of \$108,123.16, and in compensation paid to injured employees, \$60,663.60.

The expenses of the municipal engineering division increased \$98,932.39, of which \$46,456.31 is due to increased cost of repairs to roadways, the balance being in the operation and maintenance of waterworks systems in the Canal Zone.

#### CANAL ZONE ACCOUNTS.

Effective July 1, 1915, the revenues derived by the Canal Zone Government from licenses and taxes, court fees and fines, postal receipts, etc., which had theretofore been appropriated separately for the support of the Canal Zone Government, have been deposited in the Treasury of the United States and credited to "Miscellaneous receipts." Canal Zone funds were, however, credited with the sum of \$6,224.27 on account of collections applicable to the prior fiscal year which were included in the accounts of the fiscal year 1916. The sum of \$57,494.61 has been charged against the balances available June 30, 1915, on account of obligations incurred prior thereto. The balance in these funds on June 30, 1916, was \$9,061.83, of which the sum of \$2,771.60 was derived from the postal service. The total revenues of the Canal Zone made available for expenditure from the beginning have amounted to \$2,877,996.97, of which \$948,700.78 were derived from the postal service. Disbursements from these funds for public works in the Canal Zone (roads, trails, waterworks, sewers, markets, slaughterhouses, etc.) have amounted to \$929,206.89; for public schools, \$763,731.61; for the postal service, \$903,475.25; and for expenses of the administrative districts and other miscellaneous purposes, \$272,501.39, a total of \$2,868,915.14. The miscellaneous collections in the Canal Zone for the last fiscal year amounted to \$146,689.02, of which \$96,907.56 were postal revenues, a slight increase over the sum collected during the prior fiscal year, \$96,151.77.

The cash balances of Canal Zone and miscellaneous funds in the hands of the collector have been reduced from \$792,795.57, on June 30, 1915, to \$478,433.76. Of this amount \$440,553.91 were money order and \$14,001 postal saving funds. All of the expenses of the Canal Zone were paid out of the regular appropriations for civil government. For details, see Tables Nos. 42 to 45.

During the year 171,096 money orders, to the value of \$3,518,223.83, were issued, as against 170,558 orders, to the value of \$3,948,752.84, issued during the previous fiscal year. During the 10 years that the money-order offices have been established on the Isthmus,

money orders to the value of \$44,050,969.16 have been issued. The sum of \$32,516,465.51 has been paid on account of money orders drawn on the United States. (See Tables Nos. 46 to 49.)

#### CLUBHOUSE ACCOUNTS.

The revenues derived from the operation of the various clubhouses amounted to \$144,067.85, as compared with \$105,406.48 received during the prior fiscal year. The sum of \$157,610.79 was expended, of which \$21,863.47 was used for the new Ancon clubhouse, while \$9,371.54 was the cost of the Balboa yacht club building. Of this amount \$5,000 were paid by the Panama Railroad Company.

Soda-fountain receipts amounted to \$58,474.76; receipts from the sale of candies and cigars amounted to \$32,898.84; and \$10,173.22 were received as membership fees. The receipts from clubhouse activities have exceeded the expenses of operation, excluding the salaries of the secretaries and the expenses of maintaining and cleaning the buildings which were paid for from the regular appropriations and have been sufficient to permit the construction of the two buildings referred to. In addition, the cost of the swimming pool at Balboa, \$11,491.93, will be reimbursed to the Panama Railroad Company in installments of \$200 per month. The cash balance in clubhouse funds on June 30, 1916, amounted to \$7,796.56. For further detail, reference is made to Tables Nos. 50 to 52.

#### CLAIMS FOR INJURIES AND DEATHS.

There were reported during the fiscal year, 2,349 accidental injuries and 39 accidental deaths of Panama Canal employees as having occurred in connection with their work. Of the injuries reported, claims in 741 cases were approved and 35 were disapproved. In 1,564 cases there was no allowance, as the period of disability was under 7 days. Three claims were disapproved for the reason that the employee was not directly engaged in actual work at the time of injury; in 20 cases the disability was not the result of injury described; in 4 cases the evidence was insufficient to establish a claim; in 7 cases the disability commenced more than 6 months after the injury; and in 1 case the disability began after the employee's separation from the service.

Fourteen death claims were approved, 6 were disapproved, while 19 cases were pending at the end of the year. Of the 6 cases disapproved, 1 was for the reason that death was not caused by the injury received while directly engaged in actual work; in 4 cases there were no dependents entitled to compensation under the order, while in 1 case the evidence was not sufficient to establish a claim.

The sum of \$32,341.85 was allowed on account of injuries to employees of The Panama Canal, and \$33,321.07 on account of deaths of the employees. To employees of the Panama Railroad the sum of \$9,056.66 was allowed for injuries, while \$3,330.24 was allowed on account of deaths.

The sums of \$168 for injury and \$1,206 on account of deaths were allowed under the act of May 30, 1908, as amended March 4, 1911. One claim on account of an injury was allowed under the Executive order of February 26, 1913, in the sum of \$5,418.91. A prior payment had been made on this claim, which made the total allowance \$7,594.41.

In order to give some protection to the employees of contractors who might be injured in the course of employment, provisions were inserted in various contracts entered into in connection with the construction of the canal for allowing such employees or their dependents compensation under the regulations applicable to Panama Railroad and Panama Canal employees. Until the contractors were able to secure insurance to cover their liability, it was provided that The Panama Canal should pay one-half of the injury compensation allowed while the contractor was liable for the balance. In the later contracts the contractors were required to assume the entire liability.

The total amount paid by The Panama Canal as compensation on account of injuries and deaths of employees since August 1, 1908, the effective date of the act of May 30, 1908, was \$1,338,653.69. Further details as to the amounts paid, the causes of accidents and nature of injuries received will be found in Tables Nos. 53 to 61.

A digest of decisions under the Executive order of March 20, 1914, has been prepared, but it seems not necessary to publish it in view of the enactment of a new injury compensation law applicable to all Government employees. It is expected that this law, so far as it concerns Panama Canal and Panama Railroad employees, will continue to be administered by the Governor of The Panama Canal.

#### COUPON BOOKS.

During the year a new form of coupon book for use in the hotels and commissaries was substituted for the book having coupons with different denominations. This change was largely influenced by the misuse of coupons brought about by a permission which had been granted for their acceptance detached from the covers to which they belonged. The new book is in the form of a mileage book with a value of 5 cents per inch. Since the substitution of this new book the use of separate hotel books has been eliminated. Commissary coupon books to the value of \$3,250,132.50 have been issued during the year to employees for pay roll deduction. Commissary and hotel coupon books to the value of \$1,615,903.80 have been sold for cash, making a total of \$4,866,036.30.

Meal tickets to the value of \$126,397.87 were issued to silver employees. Coupon sales at the commissaries amounted to \$442,485.71 for December, 1915, which, with one exception, is the largest month's sales since the commissaries were established. The use of coupons in strips made it necessary to provide a new method of verification. After considerable experimenting, machines of two forms have been constructed at the instrument repair shop, one a hand-operated machine, and the other a motor-operated machine, both of which accurately measure the coupons and register the values thereof. For further detail reference is made to Tables Nos. 39 to 41.

#### INSPECTION OF ACCOUNTS.

The accounts of all officials and employees charged with the collection, disbursement or custody of Panama Canal, Canal Zone and Panama Railroad funds, or with funds which are semipublic, have been examined at frequent and irregular periods as contemplated by the regulations. There are about 150 officials whose money accounts are subject to inspection, besides which there are a number of accounts

of clerks issuing coupon books, meal tickets and other papers having a money value which are regularly inspected.

#### BONDS OF EMPLOYEES.

The schedule bond of employees of the canal covering those bonded for the faithful performance of their duties was renewed with the Maryland Casualty Co. at the rates provided for the preceding year, namely, 65 cents for postal clerks, \$1.25 for postmasters, and \$1.70 for other employees. The similar bond covering Panama Railroad employees was transferred from the Illinois Surety Co. to the National Surety Co. when the former company ceased to transact a surety business.

#### TIME INSPECTION.

The inspection of time books and methods of time keeping was continued with a somewhat reduced force. Numerous minor errors were discovered in the keeping of time as well as several cases of "padded" time books. The loss to the Government on account of fraudulent practices is not believed to be large due to the use of this force. In several cases time was given erroneously for the purpose of securing commissary books.

#### STOREHOUSE ACCOUNTS.

The value of materials and supplies in storehouses increased from \$3,284,244.35 July 1, 1915, to \$4,428,593.29 July 1, 1916. The issues during the year amounted to \$7,052,027.70. The sales amounted to \$502,351.70, while the transfers between stores and divisions amounted to \$2,640,352.80. The stock is accounted for under about 50 classes. (See Tables Nos. 62 and 63.)

To facilitate the giving of credit to the proper stock classification and the compilation of more complete and accurate data of the purchases, sales, and issues for use in making estimates, a Hollerith tabulating machine, using punched cards sorted mechanically was installed. Previous to its use in connection with the store accounts the machines were used to advantage in classifying collections and other items. The results have been satisfactory and have demonstrated the value of the machines in the work on the Isthmus.

#### COMMISSARY.

The commissary accounts show that supplies to the value of \$6,197,905.03 were purchased during the year as against \$5,089,080 during the preceding year. These purchases include cattle to the value of \$313,974.67. Supplies costing, delivered on the Isthmus, \$4,917,846.53 were sold for \$7,356,619.57. The net profits for the year were \$160,995.50. These profits were used in improving facilities and in preparing to care for the cattle, the purchase of which has been authorized. The net profits for the preceding year were \$71,234.34. The net profits were less than 3 per cent of the total sales without making any allowance as a return on the investment in the plant. Sales to The Panama Canal amounted to \$1,257,861.89; to other branches of the United States Government, \$1,144,289.10 as compared with \$651,869.52 for the preceding year; to steamship



companies \$295,799.67 as compared with \$150,228.70 for the preceding year. Coupon sales also show an increase. On the total value of supplies sold the average surcharge added to the cost delivered on the Isthmus was 26.12 per cent. Supplies to the value of \$4,944,836.79 were purchased in the United States; \$661,115.94 from foreign countries, and \$591,952.30 on the Isthmus, including the purchase of cattle. Commencing the first of July, 1916, the cattle business will be handled under accounts separate from commissaries. (See Tables Nos. 64 and 65.)

#### PANAMA RAILROAD.

Effective July 1, 1915, this office began the preparation of final statements of railroad operations on the Isthmus independent of the New York office of the company, and from about October 1 the final settlement of accounts for operations of the railroad on the Isthmus has been made here. Analyses were made of the various revenues and expenses and a reclassification of the operations of the company on the Isthmus prepared so as to show more clearly the results from operations as soon as practicable after the end of each month.

Special attention has been given to the accounts for terminal operations, as the results of the preceding year showed a large loss. The accounts this year show a small surplus of revenue above expenses (\$64,095.29) a very small return on an investment of nearly two and one-half million dollars. In prior years the operation of the docks has been considered a part of railroad operations. By restricting the use of the railroad to the handling of local freight only, so that it would not in any way compete with the canal, the docks became a necessary adjunct of the canal as their main use was in transferring cargo between vessels transiting the canal or calling at the terminal ports. It is the avowed intention to fix the charges made on the docks for wharfage, transferring cargo, etc., at such rates as will only insure revenue sufficient to cover operating expenses, depreciation of plant and a very small return on the investment. A separation of the operating accounts of the docks from the accounts of the railroad was therefore considered necessary.

The railroad operating revenues exceeded the expenses by \$843,025. This was entirely due to the large traffic over the railroad caused by the closure of the canal. Plantation, hotel, and stable operations show small losses. The results from motor bus, baggage transfer, and telegraph and telephone operations are exceedingly small excesses of revenues above expenses. The profit on the sale of coal was \$261,996.14. Detailed statements of the earnings, operating expenses, and statistics will be included in the annual report of that company.

Respectfully,

H. A. A. SMITH,  
*Auditor, The Panama Canal.*

Maj. Gen. GEO. W. GOETHALS, United States Army,  
*Governor, The Panama Canal., Balboa Heights, Canal Zone.*

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### THE PANAMA CANAL.

TABLE NO. 1.—*Status of authorized bond issue.*

Authorized bond issue.....		\$375,200,900.00
Appropriations by Congress.....	\$394,650,149.02	
Less appropriations for—		
Fortifications.....	\$14,689,873.30	
Presentation of launch "Louise".....	6,000.00	
Annual payment to Republic of Panama.....	1,000,000.00	
Maintenance, operation, sanitation, and civil government of canal.....	6,440,000.00	
	<u>22,135,873.30</u>	
Appropriated for canal construction.....	372,514,275.72	
Paid from appropriation for construction but exempted by law as a charge against authorized bond issue—		
Two colliers.....	2,000,000.00	
Expended for operation and maintenance of canal to June 30, 1915.....	4,289,159.00	
Stock of material and supplies for operation and maintenance of canal.....	2,225,000.00	
	<u>8,514,159.00</u>	
		<u>364,000,116.72</u>
Balance available for appropriation after June 30, 1916, within limit of cost of canal and authorized bond issue.....		11,200,783.23
Appropriated for construction by sundry civil bill for fiscal year 1917, approved July 1, 1916.....	\$9,750,000.00	
Less exemptions for—		
Two colliers.....	\$1,100,000.00	
Dock No. 6, Cristobal.....	800,000.00	
Equipping colliers "Ulysses" and "Achilles".....	250,000.00	
Covering unprotected surfaces of colliers.....	50,000.00	
Reboiling steamships "Ancon" and "Cristobal".....	600,000.00	
	<u>2,800,000.00</u>	
		<u>6,950,000.00</u>
Balance.....		4,250,783.23
Appraised value of American legation building in the City of Panama, exempted from charge to bond issue, act July 1, 1916.....		<u>22,256.00</u>
Balance available for appropriation within limit of cost of canal and authorized bond issue.....		<u>4,273,039.23</u>

NOTE.—Of the amount authorized for construction under the authorized bond issue, there has been collected for reimbursement of capital cost of public works in cities of Panama and Colon \$99,613.38, and for material sold, services rendered, etc., \$4,723,805.99, a total of \$4,823,419.37, which has been deposited as miscellaneous receipts to the credit of the general fund of the United States Treasury.

TABLE NO. 2.—General balance sheet, June 30, 1916.

ASSETS.		LIABILITIES.	
Construction of canal (Table No. 16)	\$337,203,164.07	Appropriations by Congress (Table No. 3)	\$394,650,149.02
Equipment and tools (Table No. 8)	10,710,023.81	Trust funds	32,678.97
Material, supplies, and equipment in storehouses (Table No. 10)	5,240,465.81	Security deposits	279,943.95
Fortifications	13,818,028.89	Reserves (Table No. 15)	2,330,745.96
Public works in the cities of Panama and Colon	2,419,845.55	Assets received from Canal Zone Government (Table No. 11)	544,792.37
Presentation of launch Louise to French Government	5,840.99	Panama Railroad property operated by Panama Canal (Table No. 14)	867,382.45
Reequipment loans to Panama Railroad Company	1,399,114.61	Reimbursements, account public works in Panama and Colon repaid to appropriations	396,956.06
First-mortgage bond loan to Panama Railroad Company	1,848,217.50	Accounts payable	3,322,406.95
Maintenance and operation of canal (Table No. 6)	11,277,010.71	Miscellaneous receipts, United States funds (Table No. 4)	\$13,736,665.95
Annual payment to Panama Republic for Zone rights	1,000,000.00	Less deposited in United States Treasury	13,391,153.46
Assets transferred to other departments, United States Government (Table No. 12)	1,276,395.12		345,512.49
Panama Canal property operated by Panama Railroad (Table No. 13)	1,736,644.69		
Credit to miscellaneous receipts, United States funds other than tolls	\$6,978,833.16		
Less amounts not credited to assets (Table No. 4)	2,243,128.73		
	4,735,704.43		
Work in progress (Table No. 9)	589,443.92		
Accounts receivable	1,436,060.88		
Appropriation balances subject to requisitions (Table No. 3)	4,203,230.59		
Cash in hands of fiscal officers	3,871,406.65		
Total	402,770,568.22	Total	402,770,568.22

TABLE NO. 3.—Statement of appropriations by Congress.

Canal rights from French company (act of June 28, 1902)	\$40,000,000.00
Canal Zone rights from Republic of Panama (act of Apr. 28, 1904)	10,000,000.00
Canal connecting Atlantic and Pacific Oceans:	
Act of June 28, 1902	\$10,000,000.00
Act of Dec. 21, 1905	11,000,000.00
Deficiency for fiscal year 1906 (act of Feb. 27, 1906):	21,000,000.00
Miscellaneous material purchases in United States	1,000,000.00
Miscellaneous material purchases on Isthmus	400,000.00
Payments to Panama Railroad Company	200,000.00
Isthmus pay rolls	2,100,000.00
Salaries and services in the United States	75,000.00
New equipment purchases	1,565,786.00
Reequipment of Panama Railroad	650,000.00
	5,990,786.00
Total for purchase of rights and for lump-sum appropriations common to all departments	76,990,786.00
Expenses in the United States:	
Salaries	\$1,476,056.33
Incidental expenses	583,179.36
Construction and engineering:	2,059,235.69
Pay of officers and employees	29,443,212.00
Pay of skilled and unskilled laborers	101,809,961.00
Miscellaneous material purchases, etc.	109,881,514.24
Incidental expenses on Isthmus	6,640,250.00
Construction and equipment (act of Mar. 3, 1915)	10,500,000.00
Civil administration:	258,274,937.24
Pay of officers and employees	4,507,000.00
Pay of skilled and unskilled laborers	191,000.00
Material and expenses	1,178,200.00
	5,876,200.00

## Sanitary department:

Pay of officers and employees.....	\$5,391,000.00	
Pay of skilled and unskilled laborers.....	3,036,968.00	
Material and expenses.....	5,662,367.15	

\$14,090,335.15

Reequipment of Panama Railroad.....	4,185,000.00
Relocation of Panama Railroad.....	7,815,000.00
Redemption of first-mortgage bonds of Panama Railroad Company..	2,298,367.50
Sanitation in the cities of Panama and Colon.....	800,000.00
Survey of lands, Canal Zone.....	75,000.00
Relief of Pembroke B. Banton for injuries.....	10,000.00

Total for fiscal years 1907 to 1915, inclusive..... 295,484,075.58

Total for canal construction, rights, etc., to June 30, 1915..... 372,474,861.58

## Private acts for relief:

Elizabeth G. Martin, June 17, 1910.....	\$1,200.00
Marcellus Troxell, Jan. 13, 1911.....	1,500.00
W. L. Miles, Feb. 13, 1911.....	1,704.18
Chas. A. Caswell, Mar. 2, 1911.....	1,056.00
Heirs of Robert S. Gill, July 3, 1912.....	2,520.00
Douglas B. Thompson, July 3, 1912.....	1,500.00
Allesandra Comba, July 10, 1912.....	500.00
Peter Wiggington, Feb. 7, 1913.....	500.00
Raymond R. Ridenour, Feb. 7, 1913.....	500.00
Heirs of Chas. E. Stump, Feb. 7, 1913.....	1,500.00
Parents of Edward Maher, Feb. 18, 1913.....	1,980.00
Oscar F. Lackey, Feb. 18, 1913.....	1,500.00
Pedro Sanchez, Feb. 18, 1913.....	2,000.00
John H. Cole, Feb. 18, 1913.....	1,951.38
Robert Coggen, Feb. 18, 1913.....	1,500.00
Wife of William Goodley, July 17, 1914.....	1,000.00
John Burrows, Feb. 27, 1915.....	1,433.33
F. W. Theodore Schroeter, Mar. 3, 1915.....	1,397.66
L. V. Thomas, Mar. 3, 1915.....	1,680.00

26,922.55

## Judgment of the Court of Claims, war:

Act of Aug. 26, 1912.....	196.45
Act of Mar. 4, 1913.....	900.00
Act of July 29, 1914.....	905.38
Act of Feb. 28, 1916.....	1,000.00

3,001.83

## Judgment, United States court (act of Apr. 6, 1914).....

9,489.76

## Presenting steam launch Louise to French Government (act of Aug. 25, 1914).....

6,000.00

## Fortifications:

Armament of fortifications.....	\$4,672,000.00
Army quarters, storehouses, etc.....	1,990,600.00
Buildings and materials.....	57,375.00
Causeway.....	150,000.00
Electric light and power plants.....	209,631.00
Field fortifications and camps.....	394,350.00
Fire control.....	633,301.30
Land for military purposes.....	50,000.00
Maintenance of clearings and trails.....	66,900.00
Maintenance of searchlight and electric power equipment.....	7,500.00
Preservation and repair of fortifications.....	15,000.00
Reserve equipment for fortifications.....	50,000.00
Sanitary clearing, filling, etc.....	210,000.00
Seacoast batteries.....	5,365,000.00
Searchlights for seacoast fortifications.....	364,666.00
Submarine mines.....	116,950.00
Submarine-mine structures.....	275,200.00
Surveys.....	62,000.00

14,689,873.30

## Annual payment to Republic of Panama:

Act of Mar. 4, 1913.....	\$250,000.00	
Act of Apr. 6, 1914.....	250,000.00	
Act of Jan. 25, 1915.....	250,000.00	
Act of Feb. 28, 1916.....	250,000.00	
		<u>\$1,000,000.00</u>

## Maintenance and operation of the canal:

Maintenance and operation (act of Mar. 3, 1915)	5,200,000.00	
Sanitation, Canal Zone (act of Mar. 3, 1915).....	700,000.00	
Civil government, Panama Canal Zone (act of Mar. 3, 1915).....	540,000.00	
		<u>6,440,000.00</u>

Total appropriations by Congress to June 30, 1915..... 394,650,149.02

## The sundry civil bill approved July 1, 1916, carries the following amounts for The Panama Canal:

Maintenance and operation.....	\$5,750,000.00	
Sanitation, Canal Zone.....	700,000.00	
Civil government, Panama Canal and Canal Zone	600,000.00	
Construction and equipment.....	9,750,000.00	
		<u>16,800,000.00</u>

## Fortifications:

Armament of fortifications.....	1,720,000.00	
Army quarters, storehouses, etc.....	2,000,000.00	
Alterations, maintenance, and repair, submarine-mine material.....	2,500.00	
Alteration and maintenance of armament...	68,000.00	
Maintenance of clearings and trails.....	30,000.00	
Maintenance of searchlight and electric power equipment.....	7,500.00	
Operation of fire-control installations.....	5,000.00	
Preservation and repair of fortifications.....	15,000.00	
Seacoast batteries.....	400,000.00	
Submarine mines.....	240,000.00	
Submarine mine structures.....	47,000.00	
		<u>4,535,000.00</u>

Total..... 21,335,000.00

TABLE No. 4.—*Detail of miscellaneous receipts, United States funds.*

		Amount.
Receipts involving no appropriation expenditures:		
Subsidies from Panama Railroad Company.....	\$631,875.00	
Dividends on Panama Railroad stock.....	344,945.00	
Interest, reequipment loan.....	320,799.11	
Interest, first mortgage bond loan.....	152,395.16	
Miscellaneous rentals.....	234,650.08	
Interest, public works, Panama and Colon.....	239,683.81	
Interest, Zone water-supply systems, proportion.....	67,832.62	
Interest on bank balances.....	17,387.34	
Pay-car averages.....	493.05	
Forfeitures.....	28.00	
		\$2,014,089.17
Receipts involving appropriation expenditures:		
Not credited to assets—		
Capital cost, Panama waterworks and sewers.....	27,043.04	
Capital cost, Panama pavements.....	23,487.84	
Capital cost, Colon waterworks and sewers.....	26,023.77	
Capital cost, Colon pavements.....	23,058.73	
Tools.....	6,757,832.79	
Licenses and taxes.....	14,194.06	
Court fees and fines.....	17,417.44	
Postal receipts.....	97,021.86	
Miscellaneous, Canal Zone.....	792.82	
		6,986,872.35
Credited to assets—		
Sale of property.....	850,500.11	
Sale of French material and equipment.....	95,641.21	
Sale of Panama Canal building, City of Panama.....	80,000.00	
Sale of water.....	255.43	
Mess accounts.....	46,879.48	
Hospital receipts.....	79,992.68	
Quarantine receipts.....	24,900.53	
Laundry receipts.....	7,382.01	
Rental of lands and buildings.....	41,427.24	
Rentals, miscellaneous.....	137,822.99	
Telegraph and telephone receipts.....	3,547.35	
Hotels and messes.....	758,470.34	
Hotel coupon books.....	32,238.28	
Corral receipts.....	8,628.56	
Labor furnished Panama Railroad Company.....	180,336.97	
Other labor furnished.....	27,449.55	
Repayment, reequipment loan.....	1,387,714.92	
Repayment, first mortgage bond loan.....	300,000.00	
Sale of Panama Railroad stock.....	1,300.00	
Miscellaneous.....	93,740.47	
Sale of construction material and equipment.....	565,577.87	
Profit on business operations.....	11,898.44	
		4,756,939.12
Total.....		13,736,665.95
Miscellaneous receipts deposited in United States Treasury.....		13,391,153.46
Cash on hand, June 30, 1916, collector.....		203,498.10
Cash on hand, June 30, 1916, paymaster.....		90,814.58
Amount of water rentals, Panama and Colon, credited to miscellaneous receipts.....	407,129.81	
Amount of water rentals, Panama and Colon, deposited as miscellaneous receipts.....	367,838.44	
		39,291.37
Profit on business operations, 1916, not transferred to miscellaneous receipts.....		11,898.44
Unpaid June bill.....		10.00
Total.....		13,736,665.95

TABLE No. 5.—*Statement of overhead expenses, fiscal year 1916.*

	Fiscal year—	
	1916	1915
Civil government:		
Civil affairs—		
Administration.....	\$2,411.91	\$8,831.62
Posts.....	133,708.87	21,847.83
Customs.....	19,787.98	19,162.50
Estates.....	2,417.45	2,415.10
Total civil affairs.....	158,326.21	102,317.05
Schools.....	67,218.34	
Fire protection.....	69,164.71	74,553.57
Police and prisons.....	207,492.80	219,615.46
District court.....	16,557.36	16,996.37
Magistrate courts.....	12,046.77	
District attorney.....	6,978.74	8,988.11
Canal Zone marshal.....	7,460.45	7,996.16
Municipal expenses.....	25.72	
Repairs to buildings.....		3,670.70
Total civil government.....	545,271.10	434,137.42
Charged to other interests.....	32,843.89	26,367.01
Amount apportioned.....	512,427.21	407,770.41
Health department:		
Administration.....		10,504.08
Medical storehouse.....		4,257.10
Ancon hospital.....	332,453.60	404,894.90
Colon hospital.....	48,858.40	42,006.35
Santo Tomas hospital.....	11,136.23	11,131.87
Palo Seco leper asylum.....	21,782.19	
Corozal farm and insane asylum.....	74,835.82	30,766.59
Other hospitals and dispensaries.....	44,646.35	75,529.96
Quarantine service.....	61,957.47	51,975.87
Sanitation—		
Panama.....	47,523.73	37,556.63
Colon.....	38,409.57	28,014.87
Canal Zone.....	180,180.92	113,957.76
Street cleaning and garbage disposal—		
Panama.....	53,224.65	51,060.41
Colon.....	27,301.51	23,675.14
Canal Zone.....		17,034.78
Repairs to buildings.....		14,867.94
Total health department.....	942,310.44	923,234.25
Charged to other interests.....	390,006.71	351,009.56
Amount apportioned.....	552,303.73	572,224.69
Supply department:		
Maintenance and care of administration building.....	25,770.39	20,868.11
Operation of storehouses.....	503,954.12	541,168.19
Repairs to storehouses.....	1,460.86	3,311.97
Handling freight on docks.....	58,921.93	53,459.27
Operation of quarters.....	306,606.02	229,969.30
Repairs to quarters.....	104,500.00	74,212.51
Repairs to other buildings.....	2,126.94	4,792.54
Ancon nursery.....	4,610.26	
Total.....	1,097,950.52	927,781.89
Charged to other interests.....	131,802.57	107,071.09
Amount apportioned.....	876,147.95	820,710.80
Accounting department:		
Accounting office.....	334,432.65	316,805.28
Paymaster's office.....	49,329.72	50,720.65
Collector's office.....	35,103.03	32,508.66
Total.....	418,865.40	400,034.59
Charged to other interests.....	136,118.24	90,053.02
Amount apportioned.....	282,747.16	309,981.57
Washington office:		
Assistant auditor's office.....	39,460.14	41,325.33
Disbursing clerk's office.....	10,842.27	11,104.32
General bureau.....	56,065.29	64,868.60
Purchasing expenses.....	204,638.74	214,348.34
Total.....	311,006.44	331,646.59
Charged to other interests.....	708.08	1,283.18
Amount apportioned.....	310,298.36	330,363.41



TABLE No. 5.—Statement of overhead expenses, fiscal year 1916—Continued.

	Fiscal year—	
	1916	1915
<b>Miscellaneous:</b>		
Transportation of employees on Isthmus.....	\$151,125.00	\$133,542.15
Recruiting and repatriating.....	56,463.40	164,586.56
Telephones.....	60,000.00	59,493.28
Compensation to injured employees.....	72,409.03	133,072.63
Land office.....	17,656.28	18,126.10
Special attorney.....	10,276.32	9,206.63
Adjustments.....	133.82	1,943.61
Total.....	368,063.85	519,970.36
Charged to other interests.....	27,932.60	27,332.13
Amount apportioned.....	340,131.25	492,638.23
<b>Administration:</b>		
Executive office—		
Executive.....	35,173.81	114,388.83
Miscellaneous bureaus.....		4,746.38
Correspondence bureau.....	59,425.22	58,047.38
Record bureau.....	50,514.36	39,565.09
Personnel bureau.....	25,025.49	21,356.75
Property and requisition bureau.....	28,909.18	25,829.05
General bureau.....	41,958.06	34,889.85
Timekeeping bureau.....	98,325.73	106,474.94
Clubs and playgrounds.....	48,291.36	41,566.95
Canal Record.....	10,806.28	13,585.15
Official motor cars.....	15,779.74	21,671.52
Cables and radiograms.....	7,348.42	7,008.46
Miscellaneous.....	17,647.30	32,786.53
Total executive office.....	439,204.95	521,916.88
Charged to other interests.....	96,250.14	76,808.68
Amount apportioned.....	342,954.81	445,108.20
<b>Engineer of maintenance:</b>		
Office engineer.....	11,827.05	.....
Surveys.....	41,753.55	.....
Meteorology and hydrography.....	28,835.73	.....
Total.....	82,416.33	.....
Charged to other interests.....	18,130.14	.....
Amount apportioned.....	64,286.19	.....
<b>Electrical division:</b>		
Lights—streets, lodge halls, and churches.....	5,210.39	674.62
Amount apportioned.....	5,210.39	674.62
<b>Municipal engineering:</b>		
Operation and maintenance of waterworks.....	309,254.58	250,940.84
Repairs to sewer system.....	10,444.41	16,282.07
Repairs to roads.....	109,101.21	62,644.90
Total.....	428,800.20	329,867.81
Charged to other interests.....	181,207.76	107,017.54
Amount apportioned.....	247,592.44	222,850.27
Grand total—administration.....	3,061,518.08	3,031,218.12
Charged to other interests.....	592,149.53	409,565.64
Amount apportioned.....	2,469,368.55	2,621,652.48
Total overhead expenses.....	4,549,099.62	4,389,264.41
Charged to other interests.....	1,015,000.13	786,942.21
Total amount apportioned.....	3,534,099.49	3,602,322.20
<b>Distribution:</b>		
Operation and maintenance of canal.....	2,449,590.82	1,371,905.93
Construction of canal.....	1,665,545.98	1,632,175.71
Fortifications.....	160,108.83	329,905.54
Business operations.....	245,412.63	267,463.86
Expenses of sales—construction, material, and equipment.....	12,736.70	.....
Public works in cities of Panama and Colon.....	173.53	871.16
Presentation of launch Louise to French Government.....	531.00	.....
Total.....	3,534,099.49	3,602,322.20

<sup>1</sup> In addition to this amount, \$15,732.60, representing expenses of land office and special attorney, were charged directly to "Canal construction, depopulation of Canal Zone," as an overhead charge.

TABLE NO. 6.—*Panama Canal operation and maintenance to June 30, 1916.*

	Fiscal year 1914.	Fiscal year 1915.	Fiscal year 1916.	Total to date.
Civil government.....	\$5,940.58	\$229,624.06	\$513,072.82	\$748,637.46
Health department.....	10,697.69	247,352.91	483,707.17	741,757.77
Administration.....	16,839.75	903,428.56	1,452,810.83	2,373,079.14
OPERATION AND MAINTENANCE.				
Admeasurement of vessels.....	740.71	9,926.54	7,905.40	18,572.65
Local inspection.....	752.10	3,926.98	4,075.36	8,754.44
Aids to navigation.....	812.12	48,059.59	58,848.34	107,720.05
Pilotage.....	263.42	61,513.50	41,342.29	103,119.21
Damages to vessels.....	2,417.07	1,736.61	4,153.68	6,277.26
Maintenance of transportation tracks.....		37,171.63	25,602.63	62,774.26
Operation of locks.....	4,274.16			4,274.16
Gatun Locks:				
Superintendence.....		17,398.37	12,970.82	30,369.19
Operation.....		101,494.91	80,991.61	182,486.52
Maintenance—				
Operating machinery and equipment.....	49,625.49	35,430.88	26,653.06	111,709.43
And care of emergency dams.....	2,496.60	12,478.11	7,732.63	22,707.34
Gates.....	404.13	3,221.97	56,380.25	60,006.40
Valves.....		785.28	20,956.09	21,741.37
Towing-track system.....	1,779.72	6,672.71	6,311.51	14,763.94
Towing locomotives, lines, and hawsers.....		14,804.94	18,518.56	33,323.50
Lighting and telephone system.....		2,760.35	3,061.77	5,822.12
Power control and lighting cables.....		343.51	459.26	802.77
Structures.....		25,722.17	6,624.49	32,346.66
Back fill.....		6,382.96	9,506.22	15,889.18
Miscellaneous supplies and expenses.....		2,718.52	2,079.37	4,797.89
Gatun spillway:				
Operation.....		1,128.50	860.06	1,988.56
Maintenance—				
Operating machinery and equipment.....	1,719.67	1,237.70	3,157.55	6,114.92
Gates and caissons.....	951.24	3,663.40	1,888.50	6,503.14
Structures.....		6,082.60	11,226.34	17,308.94
Gatun Dam—maintenance.....	315.10	48,458.19	20,230.04	69,003.33
Pedro Miguel Locks:				
Superintendence.....		14,921.07	16,369.88	31,290.95
Operation.....		78,964.47	49,356.32	128,320.79
Maintenance—				
Operating machinery and equipment.....	19,444.89	23,245.85	24,075.51	66,766.25
And care of emergency dams.....	2,449.53	6,914.46	9,267.78	18,631.77
Gates.....	407.92	1,941.63	3,575.47	5,925.02
Valves.....		243.22	6,424.59	6,667.81
Towing-track system.....	217.35	448.54	2,228.56	2,894.45
Towing locomotives, lines, and hawsers.....		9,808.40	11,869.82	21,678.22
Lighting and telephone system.....		2,489.34	4,828.08	7,317.42
Power control and lighting cables.....		884.00	12.58	896.58
Structures.....		9,584.95	8,710.93	18,295.88
Back fill.....	114.86	15,800.96	7,150.09	23,065.91
Miscellaneous supplies and expenses.....		1,952.18	2,770.80	4,722.98
Pedro Miguel Dam—maintenance.....		42.00	91.59	133.59
Miraflores Locks:				
Superintendence.....		17,323.13	17,577.33	34,900.46
Operation.....		102,239.26	67,258.16	169,497.42
Maintenance—				
Operating machinery and equipment.....	19,327.72	17,163.70	22,492.96	58,984.38
And care of emergency dams.....	1,824.31	7,497.89	7,675.36	16,997.56
Gates.....	1,696.38	24,550.93	24,985.05	51,232.36
Valves.....		10,616.75	26,343.99	36,960.74
Towing-track system.....	86.54	1,045.17	2,960.49	4,092.20
Towing locomotives, lines, and hawsers.....		7,711.81	10,995.76	18,707.57
Lighting and telephone system.....		2,187.47	5,520.04	7,707.51
Power control and lighting cables.....		135.48	615.07	750.55
Structures.....		11,591.96	9,492.12	21,084.08
Back fill.....		12,659.01	3,541.05	16,200.06
Miscellaneous supplies and expenses.....		3,324.44	3,243.11	6,567.55
Miraflores Dam and spillway:				
Operation.....		696.95	431.95	1,128.90
Maintenance—				
Operating machinery and equipment.....	560.75	5,104.84	1,788.97	7,454.56
Gates and caissons.....	143.52	3,118.43	162.98	3,424.93
Structures.....	151.78	755.23	750.81	1,657.82
Miraflores west dam—maintenance.....		377.17	347.72	724.89
Dredging:				
Atlantic entrance.....		125,563.30	26,478.35	152,041.65
Gaillard Cut.....		1,633,030.06	3,513,350.06	5,146,380.12
Miraflores Lake.....		2,253.44		2,253.44
Pacific entrance.....		8,628.79	20,187.63	28,816.42
Maintenance—Gatun Lake.....	16,570.44	14,488.51	20,372.17	51,431.12
Gatun-Mindi levee—maintenance.....		26,939.54	1,772.05	28,711.59
Colon west breakwater—maintenance.....		134.54	41,328.32	41,462.86

TABLE NO. 6.—Panama Canal operation and maintenance to June 30, 1916—Continued.

	Fiscal year 1914.	Fiscal year 1915.	Fiscal year 1916.	Total to date.
OPERATION AND MAINTENANCE—continued.				
Naos Island breakwater—maintenance.....		\$4,492.21	\$58.45	\$4,550.66
Operation of harbor tugs.....		2,491.77	42,720.58	45,212.35
Operation of floating derricks.....			101,858.04	101,858.04
Shop expense, Balboa balance.....		19,158.55		19,158.55
Loss on sales and services to outsiders.....	\$5,422.39	56,400.78		61,823.17
Total.....	166,030.91	4,123,128.09	6,999,750.15	11,288,909.15
Revenues:				
Tolls.....	14,618.68	4,343,383.69	2,399,830.42	6,757,832.79
Profit on sales and services to outsiders.....			11,898.44	11,898.44
Total revenues.....	14,618.68	4,343,383.69	2,411,728.86	6,769,731.23
Expenses in excess of revenues.....	151,412.23		4,588,021.29	4,519,177.92
Revenues in excess of expenses.....		220,255.60		

TABLE NO. 7.—Statement of profit and loss on business operations for fiscal year ending June 30, 1916.

	Cost.	Revenues.	Profit (+) or loss (—).
DEPARTMENT OF OPERATION AND MAINTENANCE.			
Construction and repairs.....	\$724,711.16	\$725,435.73	+ \$724.57
Shopwork.....	1,457,459.60	1,464,945.03	+ 7,395.43
Electric work.....	221,515.73	222,746.70	+ 1,230.97
Electric current.....	53,799.86	79,170.61	+25,370.75
Compressed air.....	470.84	482.91	+ 12.07
Train service and use of rolling equipment.....	43,536.10	44,396.87	+ 860.77
Tug service.....	75,643.74	53,773.17	—21,870.57
Service of other floating equipment.....	22,075.41	24,887.33	+ 2,811.92
Pilotage.....	43,946.06	45,747.00	+ 1,800.94
Wharfage.....	12,413.56	29,890.49	+17,476.93
Sales of water.....	86,545.13	103,707.93	+17,162.80
Panama waterworks.....	71,471.83	71,471.83	—
Panama pavements.....	13,072.05	13,072.05	—
Colon waterworks.....	60,539.20	60,539.20	—
Colon pavements.....	24,632.40	24,632.40	—
Handling lines.....	23,279.03	10,549.00	—12,730.03
Dredging.....	32,361.77	32,361.77	—
Minor services, supplies, and property.....	21,816.01	25,147.31	+ 3,831.30
Total, department of operation and maintenance.....	2,988,879.48	3,032,957.33	+44,077.85
SUPPLY DEPARTMENT.			
Subsistence—			
Hotel Tivoli.....	164,903.04	167,007.13	+ 2,104.09
Hotel Aspinwall.....	34,221.54	25,962.60	— 8,258.94
Line hotels.....	559,084.97	491,591.81	—67,493.16
Messes.....	126,911.54	136,170.01	+ 9,258.47
Minor services, supplies, and property.....	1,033.26	1,034.16	+ 82.90
Total, subsistence.....	886,174.35	821,765.71	—64,408.64
Quartermaster—			
Material from stock.....	1,532,149.45	1,561,647.70	+29,498.25
Rock, sand, gravel, and screenings.....	54,862.86	54,116.57	— 746.29
Printing and binding.....	17,619.67	17,970.38	+ 350.71
Corral.....	51,921.44	56,016.44	+ 4,095.00
Miscellaneous jobs.....	91,232.43	91,979.92	+ 747.49
Rental of gold quarters.....	4,790.27	4,745.03	— 45.24
Rental of silver quarters.....	26,907.18	65,656.92	+38,749.74
Garage rental.....	476.82	1,868.31	+ 1,391.49
Ancon nursery.....	2,156.70	2,156.70	—
Handling of fuel oil.....	27,018.36	32,882.63	+ 5,864.27
Operation of stores.....	54,000.00	54,000.00	—
Operation of quarters.....	60,000.00	60,000.00	—
Total, quartermaster.....	1,923,135.18	2,003,040.60	+79,905.42

TABLE NO. 7.—*Statement of profit and loss on business operations for fiscal year ending June 30, 1916—Continued.*

	Cost.	Revenues.	Profit (+) or loss (—).
<b>ACCOUNTING DEPARTMENT.</b>			
Lost metal checks.....	\$52.47	\$1,807.35	+\$1,754.88
Cablegrams.....	1,175.11	1,666.51	+ 491.40
Service to Panama Railroad.....	125,340.06	125,340.06	.....
Total, accounting department.....	126,567.64	128,813.92	+ 2,246.28
<b>HEALTH DEPARTMENT.</b>			
Aneon hospital—			
Fees.....	192,644.13	148,186.91	—44,457.22
Mess.....	9,768.47	11,050.93	+ 1,282.46
Burials.....	3,250.55	2,622.38	— 628.17
Miscellaneous.....	610.22	604.03	— 6.19
Colon hospital—			
Fees.....	16,163.74	10,383.27	— 5,780.47
Mess.....	1,036.82	862.83	— 173.99
Miscellaneous.....	138.57	138.57	.....
Palo Seco leper asylum.....	17,556.06	10,993.34	— 6,562.72
Line dispensaries.....	1,086.68	1,086.68	.....
Quarantine—			
Subsistence.....	33,684.18	14,975.18	—18,709.00
Other charges.....	4,072.33	4,954.91	+ 882.58
Sanitation—			
Panama.....	10,784.37	10,784.37	.....
Colon.....	11,417.75	11,417.75	.....
Zone.....	11,727.82	8,804.40	— 2,923.42
Street cleaning—			
Panama.....	38,000.00	38,000.00	.....
Colon.....	15,229.97	15,342.81	+ 112.84
Corozal hospital—			
Produce.....	7,266.04	7,272.62	+ 6.58
Pasturage.....	90.70	84.70	— 6.00
Burials.....	796.00	793.00	— 3.00
Insane asylum.....	35,416.18	54,791.29	+19,375.11
Sales from medical stores.....	5,353.38	5,534.94	+ 181.56
Total, health department.....	416,093.96	358,684.91	—57,409.05
<b>CIVIL GOVERNMENT.</b>			
School tuition.....	2,561.32	2,561.32	.....
Sale of school books.....	376.37	376.19	— 0.18
Police service.....	27,663.55	27,621.30	— 42.25
Minor services, supplies, and property.....	1,153.37	1,341.87	+ 188.50
Total, civil government.....	31,754.61	31,900.68	+ 146.07
<b>EXECUTIVE DEPARTMENT.</b>			
Service to Panama Railroad Company.....	78,900.00	78,900.00	.....
Photographs and prints.....	1,036.28	1,036.28	.....
Motor-car service.....	4,052.83	4,042.82	— 10.01
Minor services, supplies, and property.....	360.10	370.20	+ 10.10
Total, executive department.....	84,349.21	84,349.30	+ .09
<b>MISCELLANEOUS.</b>			
Land rental.....	4,278.41	6,505.40	+ 2,226.99
Building rental.....	1,377.87	2,064.89	+ 717.02
Land office expense.....	12,004.50	12,004.50	.....
Joint Land Commission transcripts.....	93.80	110.00	+ 16.20
Equipment rental.....	1,914.16	6,294.37	+ 4,380.21
Total, miscellaneous.....	19,668.74	27,009.16	+ 7,340.42
Total.....	6,476,623.17	6,488,521.61	+11,898.44

TABLE No. 8.—*Detail of equipment and tools.*

	Amount.		Amount.
Steamship Cristobal.....	\$716,085.43	Quartermaster.....	\$66,618.71
Steamship Ancon.....	728,271.88	Subsistence.....	14,095.06
Two colliers.....	1,974,162.14	Executive.....	25,020.65
Two floating cranes.....	890,513.46	Health.....	185,257.43
Dredging.....	4,015,200.33	Building.....	4,646.39
Mechanical.....	170,198.51	Terminals.....	21,958.95
Marine.....	711,337.79	Civil government.....	13,596.29
Locks operation.....	1,019,416.75		
Electrical.....	142,420.62	Total.....	10,710,023.81
Municipal engineering.....	11,223.42		

TABLE No. 9.—*Detail of work in progress.*

	Amount.
Uncompleted jobs, mechanical division.....	\$235,259.01
Uncompleted jobs, other divisions.....	341,335.01
Inspection of 12 towing locomotives.....	332.58
Hydraulic grader, No. 2.....	5,547.55
Hydraulic grader, No. 3.....	6,969.77
Total.....	589,443.92

TABLE No. 10.—*Detail of stores, supplies, and equipment in storehouses, by stores and divisions.*

	Amount.
Balboa store.....	\$3,071,045.82
Dry-dock store.....	349,045.31
Paraiso store.....	766,036.78
Medical store.....	56,178.05
Fuel oil.....	95,714.60
Stationery store, administration building.....	12,862.16
Printing-plant store.....	53,406.43
District quartermaster store:	
Cristobal.....	\$791.11
Gatun.....	16,731.72
Paraiso.....	1,121.80
Balboa-Ancon.....	5,659.51
	24,304.14
Total, quartermaster's stores.....	\$4,428,593.29
Material on hand with divisions, not yet charged to the work.....	548,315.04
Containers in transit.....	137,537.48
Obsolete store (credited to assets).....	126,020.00
Total.....	5,240,465.81

TABLE No. 11.—*Detail of assets received from the Canal Zone Government.*

	Amount.
Schoolhouse buildings.....	\$72,115.00
Roads.....	451,887.50
Waterworks and sewer system.....	18,500.00
Stationery stock.....	2,167.04
Miscellaneous.....	122.83
Total.....	544,792.37

TABLE NO. 12.—*Detail of assets transferred to other departments of United States Government.*

	Amount.
To Army on Canal Zone:	
Buildings—	
Corozal.....	\$205,073.50
Cristobal.....	22,261.51
Culebra.....	244,586.41
Empire.....	368,606.67
Las Cascadas.....	126,416.00
Gatun.....	28,553.91
Margarita Island.....	375.50
Toro Point.....	24,076.24
	\$1,019,949.74
Roads.....	249,200.00
Waterworks and sewer system.....	361,550.00
Allotment from appropriation "Maintenance of clearings and trails".....	16,500.00
To Alaskan Engineering Commission.....	86,523.06
	1,733,722.80
Less buildings not yet credited to other asset accounts.....	457,327.68
Total.....	1,276,395.12

TABLE NO. 13.—*Detail of Panama Canal property operated by Panama Railroad.*

	Amount.
Floating equipment.....	\$91,227.77
Rolling stock.....	764,806.20
Machinery.....	10,510.72
Docks, wooden:	
Cristobal.....	\$62,000.00
Balboa.....	8,100.00
	70,100.00
Steamships:	
Colon.....	400,000.00
Panama.....	400,000.00
	800,000.00
Total.....	1,736,644.69

TABLE NO. 14.—*Detail of Panama Railroad property operated by Panama Canal.*

	Amount.
Buildings.....	\$326,800.00
Floating equipment.....	39,585.00
Rolling stock.....	35,441.76
Machinery.....	11,852.31
Gamboa gravel plant.....	79,961.28
Concrete dock, Balboa.....	373,742.10
Total.....	867,382.45

TABLE No. 15.—*Detail of reserves.*

			Amount.
For gratuity.....			\$870,173.12
For depreciation:			
Structures—			
Shop buildings.....	\$19,907.02		
Power system.....	163,028.70		
Docks and piers.....	15,572.59		
Waterworks systems.....	36,863.13		
Storehouses.....	18,977.81	\$254,349.25	
Equipment and tools—			
Mechanical division.....	33,272.00		
Storehouses.....	7,250.06		
Dredging division.....	690,904.01		
Fortifications division.....	3,383.94		
Building division.....	426.99		
Terminal construction division.....	8,106.65		
Corrals.....	58,700.65		
Marine division.....	3,421.25		
Gatun Locks division.....	1423.97		
Pacific Locks division.....	13,813.99		
Balboa power house.....	30,607.34		
Electrical division.....	6,050.80		
Health department.....	22,510.10		
Colon breakwater.....	8.85		
Gamboa gravel plant.....	16,251.40		
Fuel-oil plants.....	22,500.00		
Contractors.....	1,914.16	901,070.24	
			1,155,419.49
For repairs:			
Structures—			
Balboa shops buildings.....	15,157.31		
Storehouses.....	7,750.14		
Quarters.....	149,221.73		
Power system.....	5,717.51		
Cristobal roundhouse.....	378.70		
Fuel-oil plants.....	20,006.68	211.39	
Equipment—			
Mechanical division.....	58,586.63		
Storehouses.....	10,177.28		
Dredging division.....	138,260.57		
Marine division.....	27,917.89		
Pacific Locks division.....	1586.18		
Motor cars.....	3,185.41		
Locomotives.....	6,740.69	244,282.29	
			244,070.90
For losses on sales of obsolete stock.....			61,082.45
Total.....			2,330,745.96

1 Debit balance.

TABLE No. 16.—*Construction of canal to June 30, 1916.*

[Quantities are expressed in cubic yards except when otherwise specified.]

FROM AND INCLUDING GATUN TO THE SEA.

	Quantities.	Amount.	Unit cost.
Prism excavation:			
Dry excavation.....	2,181,998	\$1,260,011.20	\$0.5775
Hydraulic excavation.....	29,605	10,318.87	.3485
Dredging excavation.....	39,065,660	7,721,058.24	.1976
Total direct cost.....		8,991,388.31	
Administrative and general expenses.....		2,941,413.58	
Total prism excavation.....		11,932,801.89	
Gatun spillway:			
Dry excavation.....	1,544,202	948,915.04	.6145
Preparing foundations.....	44,715	87,896.99	1.9657
Masonry—			
Plain.....	228,723	1,696,598.87	7.4177
Reinforced.....	2,456	37,470.35	15.2567
Total masonry.....		1,734,069.22	

TABLE NO. 16.—*Construction of canal to June 30, 1916—Continued.*

[Quantities are expressed in cubic yards except when otherwise specified.]

FROM AND INCLUDING GATUN TO THE SEA—Continued.

	Quantities.	Amount.	Unit cost.
<b>Gatun spillway—Continued.</b>			
Iron work.....		\$145,868.58	.....
Gates.....		90,687.83	.....
Operating machinery.....		103,150.65	.....
Back filling.....	50,183	24,935.19	\$0.4969
Total direct cost.....		3,135,523.50	.....
Administrative and general expenses.....		966,147.61	.....
Total Gatun spillway.....		4,101,671.11	.....
<b>Gatun Dam:</b>			
Dredging excavation.....	38,425	18,322.71	.4769
Dry filling.....	12,229,104	4,705,950.52	.3848
Hydraulic filling.....	10,728,965	2,645,947.37	.2466
<b>Paving and surfacing—</b>			
Excavation.....	15,078	31,704.98	2.1027
Placing riprap.....	78,590	65,299.15	.8309
Placing stone.....	15,740	38,620.09	2.4536
Surfacing (square yards).....	390,065	21,882.79	.0561
Total paving and surfacing.....		157,507.01	.....
Permanent tracks.....		12,261.60	.....
Total direct cost.....		7,539,989.21	.....
Administrative and general expenses.....		2,329,504.30	.....
Total Gatun Dam.....		9,869,493.51	.....
<b>East saddle dam:</b>			
Dry filling (direct cost).....	4,117	1,687.85	.4100
Administrative and general expenses.....		454.45	.....
Total.....		2,142.30	.....
<b>Trinidad River dam:</b>			
Dry filling (direct cost).....	72,105	54,818.81	.7603
Administrative and general expenses.....		11,894.46	.....
Total.....		66,713.27	.....
<b>Gatun-Mindí levee:</b>			
Dry filling.....	290,189	100,497.72	.3463
Hydraulic filling.....	20,398	3,326.91	.1631
Total direct cost.....		103,824.63	.....
Administrative and general expenses.....		37,504.82	.....
Total.....		141,329.45	.....
<b>Gatun Locks:</b>			
Dry excavation.....	4,660,055	2,814,729.46	.6040
Dredging excavation.....	1,756,977	495,650.69	.2821
<b>Preparing foundations—</b>			
Dry excavation.....	228,376	404,761.97	1.7724
Dredging excavation.....	19,814	36,581.03	1.8462
Filling for approach walls.....	41,661	16,008.63	.3843
Concrete pile foundations, approach walls (linear feet)...	83,670	138,689.56	1.6576
Wooden pile foundations, approach walls (linear feet)...	251,999	143,537.40	.5696
Total preparing foundations.....		739,578.59	.....
<b>Masonry—</b>			
Concrete—plain.....	1,945,487	13,260,258.29	6.8159
Concrete—reinforced.....	95,753	1,100,401.66	11.4920
Total masonry.....	2,041,240	14,360,659.95	7.0353
<b>Iron work.....</b>		1,241,241.06	.....
Gates and fender chains.....		2,840,660.64	.....
Emergency dam.....		928,531.01	.....
Operating machinery.....		3,073,489.59	.....
Concrete used in machinery installation.....	26,734	342,752.77	12.8209



TABLE No. 16.—*Construction of canal to June 30, 1916—Continued.*

[Quantities are expressed in cubic yards except when otherwise specified.]

FROM AND INCLUDING GATUN TO THE SEA—Continued.

	Quantities.	Amount.	Unit cost.
<b>Gatun Locks—Continued.</b>			
Control house—			
Masonry.....	662	\$23,067.31	\$34.8448
Iron work.....		33,927.39	
Machinery installation.....		41,696.59	
Total control house.....		98,691.29	
Locks, office building.....		16,516.25	
Buffer timbers.....		17,280.22	
Crib fenders.....		40,452.81	
Back fill.....	2,119,406	1,093,746.15	.5161
Filling center wall.....	113,163	87,048.28	.7692
Filling around south approach wall—			
Dry filling.....	7,072	3,600.90	.5092
Hydraulic filling.....	594,495	91,847.98	.1545
Total filling around south approach wall.....		95,448.88	
Cleaning up.....		31,606.06	
Total direct cost.....		28,318,083.70	
Administrative and general expenses.....		7,348,178.97	
Total Gatun Locks.....		35,666,262.67	
<b>Colon breakwaters (Table No. 17):</b>			
West breakwater—filling and trestle.....	1,276,479	3,345,890.02	2.6212
East breakwater—filling and trestle.....		2,800,286.07	
Total direct cost.....		6,146,176.09	
Administrative and general expenses.....		1,511,314.68	
Total Colon breakwaters.....		7,657,490.77	
Total, from and including Gatun to the sea.....		69,437,904.97	

## FROM GATUN TO PEDRO MIGUEL.

<b>Prism excavation and clearing:</b>			
Dry excavation.....	110,261,883	\$78,588,196.88	\$0.7127
Dredging excavation.....	6,218,999	2,811,473.22	.4521
Hydraulic excavation.....	1,633,647	342,762.79	.2098
Clearing without excavation (acres).....	2,530	155,226.38	61.3543
Total direct cost.....		81,897,659.27	
Administrative and general expenses.....		25,098,557.27	
Total prism excavation and clearing.....		106,996,216.54	

## FROM AND INCLUDING PEDRO MIGUEL TO THE SEA.

<b>Prism excavation:</b>			
Dry excavation.....	4,819,969	\$3,108,345.96	\$0.6449
Hydraulic excavation.....	1,549,904	1,075,117.67	.6937
Dredging excavation.....	40,736,898	9,484,858.21	.2328
Total direct cost.....		13,668,321.84	
Administrative and general expenses.....		4,073,580.92	
Total prism excavation.....		17,741,902.76	
<b>Pedro Miguel Dams:</b>			
Dry excavation.....	10,475	19,039.71	1.8177
Dry filling.....	699,518	314,734.74	.4499
Masonry.....	1,567	7,842.17	5.0046
Total direct cost.....		341,616.62	
Administrative and general expenses.....		92,218.76	
Total Pedro Miguel dams.....		433,835.38	

TABLE NO. 16.—*Construction of canal to June 30, 1916—Continued.*

[Quantities are expressed in cubic yards except when otherwise specified.]

FROM AND INCLUDING PEDRO MIGUEL TO THE SEA—Continued.

	Quantities.	Amount.	Unit cost.
<b>Pedro Miguel Locks:</b>			
Dry excavation.....	1,133,280	\$904,867.58	\$0.7985
Preparing foundations.....	175,987	430,205.59	2.4443
<b>Masonry—</b>			
Concrete, plain.....	839,398	4,376,954.43	5.2144
Concrete, reinforced.....	67,777	598,870.88	8.8359
Total masonry.....	907,175	4,975,825.31	5.4850
<b>Ironwork.....</b>		622,046.85	
Gates.....		1,689,540.07	
Emergency dams.....		937,958.48	
Operating machinery.....		1,866,327.76	
Concrete used in machinery installation.....	21,433	257,951.10	12.0352
<b>Control house—</b>			
Masonry.....	797	45,298.92	56.8368
Ironwork and miscellaneous.....		25,674.54	
Machinery installation.....		28,343.04	
Total control house.....		99,316.50	
<b>Lock office building.....</b>		19,476.00	
Buffer timbers.....		15,616.07	
Crib fenders.....		18,579.66	
Back fill.....	834,288	366,092.06	.4388
Filling center wall.....	220,768	105,459.15	.4777
Mess building.....		3,817.69	
Cleaning up.....		21,449.49	
Total direct cost.....		12,334,529.36	
Administrative and general expenses.....		3,264,046.12	
Total Pedro Miguel Locks.....		15,598,575.48	
<b>Miraflores east dam and spillway:</b>			
Dry excavation in site.....	242,399	303,037.56	1.2502
Dry excavation, discharge channel.....	26,338	18,368.28	.6974
<b>Masonry—</b>			
Concrete, plain.....	73,277	443,085.14	6.0467
Concrete, reinforced.....	977	14,923.61	15.2749
Total masonry.....	74,254	458,008.75	6.1681
<b>Iron work.....</b>		29,094.45	
Gates and caissons.....		48,296.22	
Operating machinery.....		105,183.50	
Concrete used in machinery installation.....	59	3,110.85	52.7263
Dike and trestle bridge.....		42,195.29	
Extension of spillway wall.....		17,602.61	
Cleaning up.....		1,888.93	
Total direct cost.....		1,026,786.44	
Administrative and general expenses.....		300,119.96	
Total Miraflores east dam and spillway.....		1,326,906.40	
<b>Miraflores west dam:</b>			
Dry excavation.....	24,459	25,549.07	1.0446
Masonry.....	4,525	20,214.95	4.4674
Dry filling.....	1,758,423	802,505.11	.4564
Hydraulic filling.....		53,490.49	
Total direct cost.....		901,759.62	
Administrative and general expenses.....		263,757.12	
Total Miraflores west dam.....		1,165,516.74	
<b>Miraflores Locks:</b>			
Dry excavation, diversion.....	5,885	2,028.98	.3448
Dry excavation, lock site.....	2,222,582	1,809,065.11	.8139
Dredging excavation, lock site.....	309,647	129,192.56	.4172
Hydraulic excavation, lock site.....	332,703	182,528.79	.5486

TABLE No. 16.—Construction of canal to June 30, 1916—Continued.

[Quantities are expressed in cubic yards except when otherwise specified.]

FROM AND INCLUDING PEDRO MIGUEL TO THE SEA—Continued.

	Quantities.	Amount.	Unit cost.
<b>Miraflores Locks—Continued.</b>			
Preparing foundations—			
Dry excavation.....	415,981	\$714,728.22	\$1.7182
Wooden pile foundations (linear feet).....	44,705	54,628.66	1.2220
Total preparing foundations.....		769,356.88	
<b>Masonry—</b>			
Concrete, plain.....	1,408,484	6,620,594.37	4.7005
Concrete, reinforced.....	71,255	768,926.55	10.7912
Total masonry.....	1,479,739	7,389,520.92	4.9938
<b>Ironwork.....</b>		\$71,408.07	
Gates.....		1,927,029.19	
Emergency dams.....		833,842.33	
Operating machinery.....		2,468,995.74	
Concrete used in machinery installation.....	28,781	339,509.32	11.7963
<b>Control house—</b>			
Masonry.....	949	54,360.38	57.2817
Ironwork and miscellaneous.....		24,519.41	
Machinery installation.....		41,606.87	
Total control house.....		120,486.66	
<b>Lock office building.....</b>		21,444.44	
Buffer timbers.....		6,507.93	
Crib fenders.....		53,081.06	
Back fill.....	2,306,252	941,051.98	.3977
Filling center wall.....	249,457	145,826.14	.5846
Mess building.....		3,666.80	
Cleaning up.....		42,953.51	
Permanent tracks.....		5,204.52	
Total direct cost.....		18,062,698.96	
Administrative and general expenses.....		4,888,710.23	
Total Miraflores Locks.....		22,951,409.19	
<b>La Boca locks and dams (abandoned):</b>			
Dry excavation.....	78,233	131,254.40	1.6777
Construction of dam.....		288,601.56	
Construction of locks.....		145,828.37	
Total direct cost.....		565,684.33	
Administrative and general expenses.....		186,063.99	
Total La Boca locks and dams.....		751,748.32	
<b>Naos Island breakwater:</b>			
Filling and trestle (direct cost).....	2,087,745	790,456.25	.3786
Administrative and general expenses.....		230,210.16	
Total Naos Island breakwater.....		1,020,666.41	
<b>Total Pedro Miguel to the sea.....</b>		60,990,560.68	
<b>Aids to navigation (Table No. 18):</b>			
Lights and buoys (direct cost).....		453,414.35	
Administrative and general expenses.....		172,120.32	
Total aids to navigation.....		625,534.67	
<b>Total canal.....</b>		238,050,216.86	

TABLE No. 16.—*Construction of canal to June 30, 1916*—Continued.

[Quantities are expressed in cubic yards except when otherwise specified.]

## MISCELLANEOUS.

	Quantities.	Amount.	Unit cost.
<b>Power producing and transmitting system:</b>			
Gatun hydroelectric power plant—			
Excavation.....		\$54,862.07	
Building.....		284,967.75	
Operating machinery.....		315,318.39	
Total Gatun hydroelectric power plant.....		655,148.21	
<b>Miraflores steam-electric power plant—</b>			
Building and site.....		233,629.74	
Operating machinery.....		16,689.10	
Total Miraflores steam-electric power plant.....		250,318.84	
<b>Transformer substations—</b>			
Cristobal.....		290,029.56	
Gatun.....		314,780.53	
Gamboa.....		23,775.03	
Miraflores.....		337,331.57	
Balboa.....		282,149.03	
Total transformer substations.....		1,248,065.72	
<b>Transmission and duct lines—</b>			
Transmission line.....		1,082,815.92	
Duct lines.....		349,831.58	
Distribution lines.....		56,764.23	
Total transmission and duct lines.....		1,489,411.73	
Total direct cost.....		3,642,944.50	
Administrative and general expenses.....		883,028.14	
Total power producing and transmitting system.....		4,525,972.64	
<b>Atlantic terminals:</b>			
Cristobal coaling station (Table No. 19).....		3,600,980.12	
Cristobal fuel-oil plant (Table No. 19).....		182,962.52	
Cristobal dry dock.....		67,387.42	
Cristobal shops.....		101,205.87	
Cristobal roundhouse.....		41,173.10	
Gatun dock.....		7,528.64	
Total direct cost.....		4,001,237.67	
Administrative and general expenses.....		436,332.02	
Total Atlantic terminals.....		4,437,569.69	
<b>Balboa terminals (Table No. 20):</b>			
Preparatory work.....		1,233,374.01	
Dredging inner harbor.....		1,499,176.46	
Main dry dock.....		2,750,022.88	
Coaling station.....		1,753,263.51	
Entrance basin.....		380,988.19	
Shops.....		3,020,640.11	
Shop office building.....		198,146.70	
Storehouses.....		522,870.25	
Docks.....		2,443,000.86	
Fuel-oil plant.....		299,705.25	
Total direct cost.....		14,101,188.22	
Administrative and general expenses.....		2,745,631.76	
Total Balboa terminals.....		16,846,819.98	
<b>Permanent townsites (Table No. 21):</b>			
Balboa-Ancon.....		1,196,197.48	
La Boea.....		152,123.75	
Pedro Miguel.....		119,492.94	
Gatun.....		15,902.76	
Cristobal.....		57,388.91	
Total direct cost.....		1,541,105.84	
Administrative and general expenses.....		307,822.50	
Total permanent townsites.....		1,848,928.34	

TABLE NO. 16.—*Construction of canal to June 30, 1916—Continued.*

[Quantities are expressed in cubic yards except when otherwise specified.]

## MISCELLANEOUS—Continued.

	Quantities.	Amount.	Unit cost.
<b>Buildings (Table No. 22):</b>			
Designing and preliminary expenses.....		\$16,079.62	
Administration building, Balboa.....		932,415.16	
Administration building, Santa Rosa.....		127,960.85	
Paraiso shops.....		2,800.00	
Storehouses.....		138,614.70	
Hotels and mess halls.....		263,896.84	
Gold quarters.....	3,119,424.99		
Silver quarters.....	375,227.62		
Ancon Hospital.....	180,800.70		
Colon Hospital.....	176,617.66		
Dispensaries.....	16,977.79		
Asylums.....	155,592.35		
Quarantine stations.....	64,835.28		
Medical storehouses.....	22,393.93		
Miscellaneous buildings, health department.....	2,113.77		
Post offices.....	35,982.62		
Schoolhouses.....	74,701.73		
Courthouses, fire and police stations, jails, etc.....	90,441.56		
Terminal office building, Balboa.....	70,594.76		
Fluviographs.....	11,534.38		
Miscellaneous buildings.....	229,928.88		
Total direct cost.....		6,108,935.19	
Administrative and general expenses.....		699,492.34	
Total buildings.....		6,808,427.53	
<b>Sanitary fills:</b>			
Ancon-Balboa.....		129,837.85	
Balboa wye.....		111,571.74	
Miraflores power house.....		16,599.52	
Pedro Miguel townsite.....		58,186.27	
Mount Hope.....		23,009.51	
Total direct cost.....		339,204.89	
Administrative and general expenses.....		61,456.79	
Total sanitary fills.....		400,661.68	
<b>Waterworks systems:</b>			
Colon-Cristobal.....		584,838.94	
Panama-Gamboa.....		1,592,979.95	
Gatun.....		241,000.00	
Other Zone systems.....		307,046.40	
Total direct cost.....		2,725,865.29	
Administrative and general expenses.....		178,139.65	
Total waterworks systems.....		2,904,004.94	
<b>Zone sewage system:</b>			
Total direct cost.....		68,037.84	
Administrative and general expenses.....		360.22	
Total Zone sewage system.....		68,398.06	
<b>Zone roadways:</b>			
Total direct cost.....		620,234.57	
Administrative and general expenses.....		11,082.14	
Total Zone roadways.....		631,316.71	
<b>Real estate:</b>			
For canal construction and flooded areas.....		866,007.56	
For auxiliary works and buildings.....		146,108.94	
For depopulation of the Canal Zone.....		948,614.69	
Total real estate.....		1,960,731.19	
<b>Miscellaneous:</b>			
Gravel reclaiming plant, Gamboa.....		13,098.88	
Relocation Panama Railroad.....		9,800,626.46	
Investment Panama Railroad stock.....		155,818.24	
Concession from Republic of Panama.....		10,000,000.00	
Purchases from New Panama Canal Co.....		38,750,572.87	
Original payment.....	\$40,000,000.00		
Expenses caring for equipment, etc.....	2,833.23		
	40,002,833.23		
Material sold or used in construction.....	1,252,260.36		
Total miscellaneous.....		58,720,116.45	
Total construction of canal.....		337,203,164.07	

TABLE NO. 17.—Detailed cost, Colon east breakwater, to June 30, 1916.

	Quantities.	Amount.	Unit cost.
COLON EAST BREAKWATER, CONSTRUCTION.			
Trestle construction:	<i>Cubic yards.</i>		
Trestle, double track.....linear feet.....	11,364	\$538,959.13	\$47.4269
Maintenance of equipment.....do.....	11,364	19,362.28	1.7038
Division expense.....do.....	11,364	18,198.42	1.6014
Total division cost.....do.....	11,364	576,519.83	50.7321
Trestle reconstruction:			
Salvaging material.....		63,379.98	.....
Value of salvaged material.....		165,760.17	.....
Trestle, single track.....linear feet.....	10,481.8	166,564.56	15.8908
Maintenance of equipment.....		5,265.98	.....
Division expense.....		19,660.75	.....
Total division cost.....		189,111.10	.....
Dry filling (a) by plowing off Lidgerwood cars:			
Excavation from Sosa Hill, core rock.....	682,037	369,284.17	.5414
Excavation from Sosa Hill, armor rock.....	67,492	78,438.37	1.1622
Transportation.....	749,529	123,597.69	.1649
Dumping.....	749,529	48,447.95	.0646
Trestle maintenance.....	749,529	23,149.51	.0309
Track maintenance.....	749,529	6,405.33	.0085
Maintenance of equipment—			
Cars.....	749,529	86,997.08	.1161
Unloaders.....	749,529	6,603.69	.0088
Plows.....	749,529	1,956.87	.0026
Miscellaneous.....	749,529	608.44	.0008
Division expense.....	749,529	8,800.86	.0117
Total division cost.....	749,529	754,289.96	1.0064
Dry filling (b) placing with derrick barges:			
Reloading from storage.....		77.70	.....
Water transportation.....		83.96	.....
Placing armor.....		126.78	.....
Division expense.....		62.85	.....
Total division cost.....		351.29	.....
Placing concrete blocks:			
Concrete blocks—			
7 feet.....	76,011.2	220,932.90	2.9066
6 feet 3 inches.....	23,913.0	88,099.59	3.6842
5 feet 3 inches.....	10,700.7	43,282.32	4.0448
4 feet 3 inches.....	4,807.6	17,491.07	3.6382
Rail transportation—			
Gambao to Coco Solo.....	76,011.2	7,953.27	.1046
Cristobal to Coco Solo.....	15,508.3	506.65	.0327
Placing with derrick barges—			
Loading into barges.....	66,019.8	3,571.03	.0541
Shifting barges.....	66,019.8	3,143.22	.0476
Operation, derrick barges.....	66,019.8	11,862.40	.1797
Operation, rock barges.....	66,019.8	2,738.65	.0415
Placing, plowing off Lidgerwood cars—			
Dumping.....	49,412.7	6,145.84	.1244
Trestle maintenance.....	49,412.7	618.17	.0125
Maintenance of equipment—			
Cars.....	115,432.5	12,190.27	.1056
Cranes.....	66,019.8	676.64	.0102
Derrick barges.....	66,019.8	12,793.83	.1938
Rock barges.....	66,019.8	2,198.01	.0333
Miscellaneous.....	115,432.5	1,974.53	.0171
Division expense.....	115,432.5	4,397.04	.0381
Total division cost.....	115,432.5	440,575.43	3.8167
Scow fill from Gaillard Cut:			
Excess cost of dumping.....		616.47	.....
Filling, hydraulic:			
Fill proper.....	326,213	257,681.87	.7899
Fill for trestle reconstruction.....	215,644	60,884.90	.2823
Total division cost.....	541,857	318,566.77	.5879
Plant.....		520,255.22	.....
Total division cost Colon east breakwater.....		2,800,286.07	.....

¹ Indicates credit.

TABLE NO. 18.—Detailed cost, aids to navigation, to June 30, 1916.

Item.	Amount.	Item.	Amount.
Preliminary work.....	\$49,275.50	Punta Mala keeper's house.....	\$1,346.49
Sailing chart, preparation.....	1,018.67	Bona Island light.....	3,287.23
East breakwater beacon.....	1,616.00	Taboguilla light.....	3,601.76
West breakwater light.....	28,990.50	Temporary lights, Pacific entrance.....	692.81
West breakwater beacon.....	8,168.52	Reference targets.....	9,029.53
Beacon, dock 13, Atlantic.....	49.28	Reference points.....	148.55
Beacon, coal chute, Atlantic.....	4.14	Transmission lines:	
Beacon No. 1, Atlantic.....	1,678.94	Atlantic entrance, west.....	\$4,153.76
Beacon No. 2, Atlantic.....	584.83	Atlantic entrance, east.....	5,425.92
Beacon No. 3, Atlantic.....	707.56	To Towers Nos. 23 and	
Beacon No. 4, Atlantic.....	2,188.63	24, lake.....	989.96
Tower No. 5, Atlantic.....	5,423.56	To Tower No. 25, lake.....	101.30
Tower No. 6, Atlantic.....	3,217.70	To Tower No. 28, lake.....	1,131.70
Tower No. 1, lake.....	6,490.51	Bas Obispo conduit.....	8,236.97
Tower No. 2, lake.....	12,401.92	Bas Obispo to Pedro	
Tower No. 3, lake.....	3,723.14	Miguel.....	22,701.21
Tower No. 4, lake.....	3,056.73	Pacific entrance, west.....	2,502.30
Tower No. 5, lake.....	7,824.56	Pacific entrance, east.....	4,737.52
Tower No. 6, lake.....	3,934.86	Total transmission lines.....	49,982.64
Tower No. 7, lake.....	3,090.25	Gas buoys, general, installation.....	12,876.46
Tower No. 8, lake.....	4,487.83	Gas buoys, 22-foot shoal, Limon Bay.....	772.43
Tower No. 9, lake.....	3,103.56	Spar buoys.....	18,141.25
Tower No. 10, lake.....	3,622.72	Mooring stations:	
Tower No. 12, lake.....	5,516.27	Dock No. 13, dolphins.....	\$303.37
Tower No. 13, lake.....	4,305.56	Gamboa, surveys.....	123.21
Tower No. 14, lake.....	3,232.77	Gamboa, dolphins.....	8,257.64
Tower No. 15, lake.....	4,220.71	Gamboa, mooring buoys.....	180.19
Tower No. 16, lake.....	4,732.24	Gamboa, mooring wharf.....	1,074.64
Tower No. 17, lake.....	4,531.08	Empire, surveys.....	3.57
Tower No. 18, lake.....	5,979.96	Empire, mooring wharf.....	1,668.59
Tower No. 19, lake.....	4,244.49	Paraiso.....	3,519.30
Tower No. 21, lake.....	3,221.27	Pedro Miguel, mooring	
Tower No. 22, lake.....	3,248.14	posts.....	48.15
Tower No. 23, lake.....	6,744.68	Balboa, private craft.....	315.34
Tower No. 24, lake.....	2,382.13	Balboa, buoys.....	803.14
Tower No. 25, lake.....	4,162.51	Gatun, concrete dock.....	5,276.14
Tower No. 26, lake.....	4,187.97	Total mooring stations.....	21,573.28
Beacon No. 11, lake.....	2,398.49	Signal stations:	
Beacon No. 27, lake.....	231.69	Empire.....	\$3,479.34
Beacon No. 28, lake.....	1,390.53	Gamboa.....	3,874.72
Beacon No. 29, lake.....	207.84	Gatun, arrow.....	1,043.83
Beacon No. 30, lake.....	1,028.66	Pedro Miguel, arrow.....	1,093.71
Beacon No. 31, lake.....	68.93	Miraflores, arrow.....	1,114.38
Beacons Nos. 1-37, Gaillard Cut.....	19,734.93	Cucaracha.....	49.44
Beacon No. 38, Gaillard Cut.....	1,291.51	Washington Hotel.....	582.92
Channel lights, Gaillard Cut.....	2,379.40	Sosa Hill.....	5,214.56
Tower No. 1, Pacific.....	7,728.79	Total signal stations.....	16,452.90
Tower No. 2, Pacific.....	4,958.77	Whistle signs, Gaillard Cut.....	280.57
Tower No. 3, Pacific.....	8,347.78	Telephone system, Balboa to Flamen-	
Tower No. 4, Pacific.....	7,388.74	co Island.....	525.44
Tower No. 12, Pacific.....	2,420.56	Experimental illumination.....	1,293.92
Tower No. 13, Pacific.....	2,158.37	Spart parts:	
Beacon No. 5, Pacific.....	2,729.59	Beacons, common.....	\$1,730.26
Beacon No. 6, Pacific.....	823.70	Beacon lanterns.....	843.63
Beacon No. 7, Pacific.....	2,146.93	Buoy sinkers.....	286.06
Beacon No. 8, Pacific.....	2,047.10	Red sectors.....	70.00
Beacon No. 9, Pacific.....	819.04	Total spare parts.....	2,929.95
Beacon No. 10, Pacific.....	357.00	Total division cost.....	453,414.35
Beacon No. 11, Pacific.....	148.58		
Beacon No. 17, Pacific.....	744.63		
Beacon No. 19, Pacific.....	719.39		
Beacon No. 21, Pacific.....	731.43		
Punta Mala light.....	22,107.07		

TABLE NO. 19.—Detailed cost, Cristobal terminals, to June 30, 1916.

	Quantities.	Amount.	Unit cost.
COALING PLANT.			
Preliminary and general work:	<i>Cubic yards.</i>		
Designing.....		\$12,847.65	.....
Surveys.....		10,794.68	.....
Boring and test pits.....		352.41	.....
Temporary tracks.....		43,076.85	.....
Inspection in the United States.....		62,757.69	.....
Inspection on the Isthmus.....		20,344.66	.....
Preliminary operation and maintenance.....		67.23	.....
Division expense.....		13,270.71	.....
Total division cost.....		163,511.88	.....
Dredging:			
Clearing.....	1,419,517	2,201.84	\$0.0016
Operation dipper dredges.....	73,623	4,351.72	.0591
Maintenance dipper dredges.....	73,623	4,458.48	.0606
Operation ladder dredges.....	347,581	39,616.43	.1140
Maintenance ladder dredges.....	347,581	24,516.27	.0705
Depreciation ladder dredges.....	122,286	1,007.00	.0082
Operation tugs, clapets, and scows.....	421,204	25,770.31	.0612
Maintenance tugs, clapets, and scows.....	421,204	11,392.90	.0270
Depreciation tugs, clapets, and scows.....	122,286	1,031.96	.0084
Operation pipe-line dredges.....	998,313	172,781.95	.1731
Maintenance pipe-line dredges.....	998,313	131,934.46	.1322
Depreciation pipe-line dredges.....	348,190	6,422.97	.0184
Pipe lines.....	998,313	34,071.78	.0341
Dikes.....	998,313	7,632.19	.0076
Channel lights.....	1,419,517	1,492.15	.0011
Ditching.....	1,419,517	36.65	.....
Drilling.....	1,419,517	49,836.95	.0351
Blasting.....	1,419,517	48,120.25	.0339
Operation miscellaneous floating equipment.....	1,419,517	9,561.49	.0067
Maintenance miscellaneous floating equipment.....	1,419,517	3,453.64	.0024
Depreciation miscellaneous floating equipment.....	470,476	8,772.42	.0019
Maintenance drill barges.....		2,981.64	.....
Depreciation, all equipment, prior to June 30, 1915.....	697,908	11,454.25	.0164
Division expense.....	1,419,517	41,146.03	.0290
Total division cost.....	1,419,517	636,145.73	.4481
Coal pocket and under wharves.....	221,354	116,976.50	.5285
Basin alongside.....	1,198,163	519,169.23	.4330
Foundations, retaining wall construction:			
Surveys.....		1,729.86	.....
Piling in place..... linear feet.....	89,993	41,700.03	.4634
Excavation for foundations.....	5,127	6,288.94	1.2266
Concrete.....	7,413	31,511.15	4.2506
Reinforcement in place.....		1,525.67	.....
Fixed irons in place.....		2,681.61	.....
Forms for retaining wall.....		7,518.09	.....
Maintenance of equipment.....		3,808.26	.....
Plant arbitrary.....		7,869.09	.....
Division expense.....		5,572.90	.....
Total division cost.....		110,205.60	.....
Foundations, caisson construction:			
Surveys.....		3,516.07	.....
Cylinders in place.....		72,885.50	.....
Cost of steel cylinders.....		186,566.55	.....
Excavation in cylinders.....	16,739.5	37,753.04	2.2553
Concrete in cylinders.....	20,917	100,255.25	4.7930
Reinforcing in cylinders.....		55,471.42	.....
Trestles.....		56,377.60	.....
Forms for cylinders.....		3,093.75	.....
Ties between cylinders.....		5,781.14	.....
Fixed iron.....		6,061.03	.....
Maintenance of equipment.....		33,581.77	.....
Plant arbitrary.....		49,524.45	.....
Division expense.....		34,899.76	.....
Total division cost.....		645,767.33	.....
Back filling:			
Transportation.....	45,433	599.54	.0132
Tracks.....	45,433	904.94	.0199
Filling and grading.....	45,433	8,060.17	.1774
Maintenance of equipment.....	45,433	2,976.93	.0655
Division expense.....	45,433	1,616.08	.0356
Fill for permanent storage yard.....	69,125	18,336.49	.2653
Total division cost.....	114,558	32,494.15	.2836



TABLE NO. 19.—Detailed cost, Cristobal terminals, to June 30, 1916—Continued.

	Quantities.	Amount.	Unit cost.
COALING PLANT—continued.			
Floor:	Cubic yards.		
Surveys.....		\$1,482.82	.....
Reinforcements in place.....		21,811.96	.....
Fixed irons in place.....		7,450.70	.....
Concrete for floors.....	17,211	80,241.54	\$4.6351
Forms for floors.....		63,886.44	.....
Structural steel decking.....		268,105.57	.....
Finishing.....		2,572.35	.....
Plant arbitrary.....		7,458.55	.....
Division expense.....		21,278.38	.....
Total division cost.....		474,288.31	.....
Superstructure:			
Stocking and reclaiming bridges—			
Contract payments.....		418,984.01	.....
Testing.....		101.24	.....
Other erection expenses.....		7,333.29	.....
Division expense.....		67.94	.....
Total division cost.....		426,486.48	.....
Unloader towers—			
Contract payments.....		300,333.46	.....
Testing.....		3,813.16	.....
Other erection expenses.....		8,050.81	.....
Division expense.....		1,191.01	.....
Total division cost.....		313,388.44	.....
Reloader towers—			
Contract payments.....		197,801.89	.....
Testing.....		120.53	.....
Other erection expenses.....		23.39	.....
Division expense.....		42.84	.....
Total division cost.....		197,988.70	.....
Conveyor system—			
Contract payments.....		457,662.64	.....
Other erection expenses—			
Wharf bunker.....		15,212.30	.....
Tower.....		1,048.12	.....
Viaduct system.....		2,008.52	.....
Transformer house.....		2,948.43	.....
Division expense.....		3,752.66	.....
Total division cost.....		482,632.67	.....
Accessories:			
Installation of controlling devices.....		2,521.11	.....
Electrical installation.....		4,904.83	.....
Division expense.....		42.19	.....
Total division cost.....		7,468.18	.....
Miscellaneous:			
Permanent tracks on ground.....		2,143.83	.....
Tracks and fastenings.....		26,571.91	.....
Concrete in permanent tracks.....		321.94	.....
Track scales.....		4,471.27	.....
Fender system.....		30,934.69	.....
Riprapping under wharves.....		7,084.54	.....
Permanent water mains.....		13,615.85	.....
Retaining walls for private coal storage.....		196.76	.....
Grading and cleaning up dry storage.....		4,900.35	.....
Cleaning up outside coal storage area.....		2,151.64	.....
Office and machine shop.....		20,895.06	.....
Toilets.....		7.58	.....
Division expense.....		8,738.99	.....
Total division cost.....		122,034.41	.....
Plant, to be adjusted.....		11,431.76	.....
Total division cost coaling plant.....		2,964,834.39	.....
Total division cost coaling plant, including dredging.....		3,600,980.12	.....

<sup>1</sup> Indicates credit.

TABLE NO. 19.—Detailed cost, Cristobal terminals, to June 30, 1916—Continued.

	Quantities.	Amount.	Unit cost.
<b>FUEL-OIL HANDLING PLANT.</b>			
<b>Storage:</b>			
United States tanks Nos. 1 and 2—	<i>Cubic yards.</i>		
Surveys.....		\$298. 68	
Land damages.....		2, 415. 00	
Roadways and walks.....		3, 961. 11	
Tank foundations.....		4, 505. 85	
Contract price.....		31, 405. 13	
Concrete gutters and aprons.....		1, 103. 37	
Painting.....		2, 119. 31	
Miscellaneous pipe-line connections.....		3, 642. 12	
Miscellaneous charges.....		238. 17	
Design and supervision.....		2, 236. 81	
Total division cost.....		51, 928. 55	
United States tank No. 9—			
Tank foundation.....		187. 03	
Tank erection.....		838. 57	
Fire walls.....		1, 041. 93	
Design and supervision.....		176. 89	
Total division cost.....		2, 244. 42	
<b>Oil-pump plant:</b>			
Boiler and pump house—			
General.....		6, 585. 31	
Design and supervision.....		2, 901. 86	
Structure.....		10, 025. 69	
Concrete drains and sewers.....		4, 611. 94	
Machinery foundations.....		2, 666. 97	
Cost of equipment.....		13, 612. 46	
Brick setting.....		3, 009. 15	
Installation, boiler and stack.....		2, 287. 21	
Installation, auxiliary apparatus.....		4, 404. 98	
Installation, steam and water fittings.....		3, 844. 43	
Installation, oil pumps.....		1, 033. 26	
Electrical installation.....		536. 47	
Manifold—			
Foundations.....		1, 039. 92	
Installation.....		15, 427. 44	
Total division cost.....		71, 987. 09	
<b>Oil docks:</b>			
Design and supervision.....		115. 97	
Preliminary and general work.....		12. 03	
Installation of equipment.....		115. 15	
Total division cost.....		243. 15	
<b>Pipe lines:</b>			
Installation 10-inch lines.....		29, 766. 91	
Installation 12-inch lines.....		12, 414. 82	
Installation 10-inch line to Gatun.....		1, 679. 04	
Total division cost.....		43, 860. 77	
Total division cost oil-fuel storage.....		170, 263. 98	
<b>Gasoline storage:</b>			
Tank foundation.....		877. 76	
Tank.....		6, 562. 13	
Housing.....		3, 221. 26	
Pipe lines.....		1, 138. 03	
Fencing, etc.....		559. 11	
Fire walls.....		196. 70	
Design and supervision.....		143. 55	
Total division cost gasoline storage.....		12, 698. 54	
Total division cost oil-fuel and gasoline storage.....		182, 962. 52	
Total division cost Cristobal terminals.....		3, 783, 942. 64	

TABLE NO. 20.—Detailed cost, terminal facilities, Balboa, to June 30, 1916.

	Quantities.	Amount.	Unit cost.
PREPARING SITES, GENERAL.			
Preliminary and general work:	Cubic yards.		
Surveys		\$31,544.28	
Clearing		14,235.77	
Boring and test pits		1,297.82	
Removal of buildings		67,579.19	
Removal and rearrangement of Panama Railroad tracks		110,931.32	
Removal of roads, water mains, and lines		19,818.21	
Panama Railroad dock		10,385.99	
Removal of quartermaster material yard		5,609.56	
Construction new dredge landing		1,304.02	
Removal of landing stage for Union Oil Co.		10,627.07	
General tracks		58,473.83	
Drainage around Balboa wye and yards		699.36	
Division expense		11,579.81	
Total division cost		344,116.23	
Preparing sites, general:			
Fill between Panama Railroad yard and back line of piers from stations 0 to 30	220,768	65,801.85	\$0.2981
Fill back of quay wall "D-E" to station 12, west end of building No. 1	65,822	57,516.02	.8738
Fill from Panama Railroad yard to Diablo	446,660	258,119.44	.5779
Diablo Hill excavation	233,300	88,397.46	.3789
Sosa Hill and Sosa Dam excavation	418,562	245,457.01	.5864
Concrete drain ditch, Sosa Hill	368	5,003.12	13.5954
Division expense		5,599.67	
Total division cost		725,894.57	
Curundu River drainage culvert:			
Preliminary and general work—			
Surveys		288.06	
Designing		24.00	
Total		312.06	
Foundations—			
Clearing		153.16	
Excavation by hand	2,471	3,786.11	1.5322
Wooden piles	18,412 linear feet	16,883.55	.9170
Back filling		111.59	
Pumps		328.88	
Total		21,263.29	
Concrete—			
Concrete	1,664	12,121.64	7.2846
Reinforcements		4,460.93	
Pumps		909.36	
Tracks		29.71	
Tidal gate		144.53	
Total		17,666.17	
Division expense		1,895.49	
Total division cost		41,137.01	
Total division cost, preliminary work, and preparing site		1,111,147.81	
Dredging inner harbor:			
Clearing	8,350,467	8,211.80	.0010
Operation sea-going suction dredges	224,951	10,338.51	.0460
Repairs seagoing suction dredges	224,951	3,505.95	.0156
Depreciation seagoing suction dredges	224,951	1,260.57	.0056
Operation small ladder dredges	2,240,897	97,596.22	.0436
Repairs small ladder dredges	2,240,897	57,420.67	.0256
Depreciation small ladder dredges	2,240,897	12,635.56	.0056
Operation 3-yard ladder dredges	10,000	1,166.71	.1167
Repairs 3-yard ladder dredges	10,000	853.11	.0853
Depreciation 3-yard ladder dredges	10,000	100.00	.0100
Operation small dipper dredges	17,899	2,747.34	.1535
Repairs small dipper dredges	17,899	1,195.14	.0668
Operation pipe-line dredges	5,856,720	286,740.58	.0490
Repairs pipe-line dredges	5,856,720	191,913.86	.0328
Depreciation pipe-line dredges	5,856,720	107,751.82	.0184
Operation tugs, clapnets, and scows	2,268,796	144,310.93	.0636
Repairs tugs, clapnets, and scows	2,268,796	62,727.93	.0276
Depreciation tugs, clapnets, and scows	2,268,796	917.08	.0004
Operation rock breakers	24,504	4,203.86	.1716

TABLE NO. 20.—Detailed cost, terminal facilities, Balboa, to June 30, 1916—Continued.

	Quantities.	Amount.	Unit cost.
PREPARING SITES, GENERAL—continued.			
Dredging inner harbor—Continued.	<i>Cubic yards.</i>		
Repairs rock breakers.....	24,504	\$3,539.53	\$0.1444
Depreciation rock breakers.....	24,504	81.16	.0033
Operation drill barges.....	417	918.67	2.2030
Repairs drill barges.....	417	36.21	.0868
Depreciation drill barges.....	417	37.75	.0905
Operation miscellaneous floating equipment.....	8,350,467	32,088.56	.0038
Repairs miscellaneous floating equipment.....	8,350,467	23,972.52	.0029
Depreciation miscellaneous floating equipment.....	8,350,467	89.62	.....
Blasting.....	8,350,467	76.33	.....
Pipe lines.....	5,856,720	73,558.15	.0126
Dikes.....	5,856,720	4,273.45	.0007
Channel lights.....	6,350,467	3,316.11	.0004
Ditching.....	8,350,467	1,974.95	.0002
Lockage.....	8,350,467	25.22	.....
Sluicing.....	8,350,467	2,219.83	.0003
Division expense.....	8,350,467	76,138.65	.0091
Total division cost.....	8,350,467	1,217,944.35	.1459
Reclaiming land:			
Clearing.....	5,893,731	459.91	.0001
Pipe lines.....	5,603,731	23,399.58	.0040
Dikes.....	5,893,731	78,801.59	.0134
Operation relay pumps.....	5,893,731	139,000.27	.0236
Repairs relay pumps.....	5,893,731	19,738.31	.0033
Ditching.....	5,893,731	4,597.07	.0008
Plant arbitrary.....	5,893,731	1,391.09	.0002
Division expense.....	5,893,731	13,844.29	.0023
Total division cost.....	5,893,731	281,232.11	.0477
Total division cost dredging.....		1,499,176.46	.....
Entrance basin dry excavation:			
Surveys.....	402,455	18.17	.0001
Clearing.....	402,455	5,488.25	.0136
Drilling.....	402,455	58,890.56	.1461
Blasting.....	402,455	39,449.64	.0980
Excavation by power.....	402,455	36,038.35	.0895
Excavation by hand.....	402,455	95.80	.0002
Tracks.....	402,455	52,642.90	.1308
Transportation.....	402,455	50,698.94	.1260
Incline trestle.....	402,455	2,020.98	.0050
Dumps.....	402,455	4,719.56	.0117
Drainage and pumps.....	402,455	23,371.32	.0582
Maintenance of equipment.....	402,455	45,164.49	.1124
Plant arbitrary.....	402,455	52,440.70	.1303
Division expense.....	402,455	13,151.78	.0327
Total division cost.....	402,455	384,191.44	.9546
Less spoil for other divisions.....	4,271	3,203.25	.7500
Net division cost entrance basin.....		380,988.19	.....
MAIN DRY DOCK.			
Preliminary and general work:			
Designing.....		38,712.02	.....
Surveys.....		31,350.08	.....
Boring and test pits.....		10,657.10	.....
Inspection in the United States.....		4,327.31	.....
Inspection on the Isthmus.....		235.67	.....
Granite from Cocoli Island.....		12.85	.....
Testing material.....		2,325.35	.....
Construction tracks.....		12,461.40	.....
Cleaning up.....		16,012.50	.....
Auxiliary pumping.....		4,879.45	.....
Division expense.....		11,083.33	.....
Total division cost.....		132,057.06	.....
Dry excavation:			
Clearing.....	596,885	7,898.96	.0132
Drilling.....	596,885	90,456.87	.1515
Blasting.....	596,885	59,921.92	.1004
Excavation by power.....	596,885	53,046.22	.0880
Excavation by hand.....	596,885	14,785.00	.0248
Tracks.....	596,885	77,221.07	.1294
Transportation.....	596,885	79,378.51	.1330
Incline trestle.....	596,885	4,140.76	.0069
Dumps.....	596,885	6,792.62	.0114

TABLE NO. 20.—Detailed cost, terminal facilities, Balboa, to June 30, 1916—Continued.

	Quantities.	Amount.	Unit cost.
MAIN DRY DOCK—continued.			
Dry excavation—Continued.	<i>Cubic yards.</i>		
Drainage and pumps.....	596, 885	\$26, 176. 62	\$0. 0439
Maintenance of equipment.....	596, 885	74, 372. 10	. 1246
Plant arbitrary.....	596, 885	75, 475. 42	. 1264
Division expense.....	596, 885	21, 147. 40	. 0354
Total division cost.....	596, 885	590, 813. 56	. 9898
Less spoil for other divisions.....	6, 836	5, 127. 00	. 7500
Net division cost.....		585, 686. 56	
Preparing foundations:			
Drilling.....	38, 411	11, 674. 51	. 3039
Blasting.....	38, 411	3, 183. 79	. 0829
Excavation.....	38, 411	45, 996. 09	1. 1975
Tracks.....	38, 411	218. 43	. 0058
Transportation.....	38, 411	7, 512. 88	. 1956
Drainage and pumps.....	38, 411	3, 565. 52	. 0928
Maintenance of equipment.....	38, 411	7, 357. 33	. 1915
Division expense.....	38, 411	7, 119. 25	. 1853
Total division cost.....	38, 411	86, 627. 80	2. 2553
Less spoil for other divisions.....	984	738. 00	. 7500
Net division cost.....		85, 889. 80	
Concrete masonry, mass:			
Cement.....	141, 092	210, 722. 57	1. 4935
Sand.....	141, 092	39, 200. 77	. 2778
Stone.....	141, 092	108, 584. 35	. 7696
Mixing.....	141, 092	39, 661. 22	. 2811
Forms.....	141, 092	79, 163. 17	. 5611
Placing.....	141, 092	49, 372. 47	. 3499
Drainage and pumps.....	141, 092	654. 92	. 0046
Maintenance of equipment.....	141, 092	15, 450. 70	. 1096
Plant arbitrary.....	141, 092	21, 397. 49	. 1517
Division expense.....	141, 092	17, 367. 01	. 1231
Total division cost.....	141, 092	581, 574. 67	4. 1220
Concrete masonry, reinforced:			
Cement.....	42, 432	90, 177. 11	2. 1252
Sand.....	42, 432	5, 888. 63	. 1388
Stone.....	42, 432	42, 528. 47	1. 0023
Mixing.....	42, 432	13, 965. 60	. 3291
Forms.....	42, 432	56, 697. 95	1. 3362
Placing.....	42, 432	17, 019. 88	. 4011
Reinforcements.....	42, 432	31, 553. 61	. 7436
Drainage and pumps.....	42, 432	183. 37	. 0043
Maintenance of equipment.....	42, 432	6, 754. 55	. 1592
Plant arbitrary.....	42, 432	9, 206. 03	. 2170
Division expense.....	42, 432	12, 142. 83	. 2862
Total division cost.....	42, 432	286, 118. 03	6. 7430
Granite:			
Handling to site.....		1, 405. 15	
Placed in sill.....		14, 364. 88	
Placed in walls.....		18, 998. 32	
Division expense.....		1, 301. 00	
Total division cost.....		36, 069. 35	
Pumping plant:			
Contract payments.....		112, 216. 99	
Installation—			
Switchboards and cable runs.....		4, 473. 86	
Main and drain pump motors.....		954. 28	
Pumps, piping, valves, shafting and bearings.....		6, 575. 58	
Structural steel for floors and stairs.....		4, 796. 14	
Pressure plant, control board, pressure piping and indicator wiring.....		3, 608. 36	
Water level indicator and drain pump alarm, bilge pump motor and its control.....		261. 89	
Alterations.....		171. 08	
Other expenses.....		3, 226. 58	
Maintenance of equipment.....		1, 720. 01	
Division expense.....		1, 513. 89	
Total division cost.....		139, 818. 66	
Miter gates: Original cost of gates and operating machinery.....		132, 147. 15	

TABLE NO. 20.—*Detailed cost, terminal facilities, Balboa, to June 30, 1916—Continued.*

	Quantities.	Amount.	Unit cost.
MAIN DRY DOCK—continued.			
Erection of gates:	<i>Cubic yards.</i>		
Preliminary work.....		\$11,201.38	
Handling material to site.....		2,136.79	
Bolting up and reaming.....		22,729.38	
Erecting..... tons.....	1,046.94	9,811.40	\$9.3715
Riveting.....		14,176.10	
Drilling and tapping.....		3,211.85	
Grinding.....		1,096.63	
Caulking.....		4,430.72	
Finishing.....		3,433.74	
Painting.....		7,870.41	
Alterations.....		648.85	
Greenheart.....		26,920.23	
Gate carriage.....		8,318.62	
Mechanical installation.....		447.70	
Foot walks and handrails.....		381.68	
Inspection.....		2,933.04	
Maintenance of equipment.....		3,542.89	
Division expense.....		7,192.66	
Total division cost.....		130,484.07	
Miter gate machinery:			
Installation.....		4,903.32	
Division expense.....		192.97	
Total division cost.....		5,096.29	
Miter gate anchorage:			
Installation.....		302.32	
Division expense.....		34.92	
Total division cost.....		337.24	
Back filling:			
Filling in place.....	86,780.00	50,746.32	.5848
Plant arbitrary.....	86,780.00	6,925.14	.0798
Division expense.....	86,780.00	2,488.66	.0286
Total division cost.....	86,780.00	60,160.12	.6932
Miscellaneous:			
Valves, wagon body, with machinery and accessories.....		28,406.51	
Valves, sluice, with accessories, including housings.....		33,930.34	
Blocks and fenders.....		860.15	
Capstans.....		9,137.82	
Bollards.....		4,848.87	
Gratings.....		4,889.42	
Sewerage.....		26,300.65	
Stairs, extra work.....		1,202.45	
Crane tracks.....		38,826.26	
Fittings and bilge block slides.....		57,435.82	
Structural reinforcement at caisson seat.....		6,245.48	
Ducts, manholes, transformers and cables.....		9,853.18	
Handrails and stanchions.....		910.26	
Pump well, motor floor, house over, stairs and fittings.....		2,602.87	
Piping and valves for air and water.....		25,731.76	
Rail reinforcement, including anchoring to rock.....		20,575.49	
Water stops, yellow metal.....		3,563.95	
Grouting under pressure.....		1,466.16	
Finishing and painting concrete walls and floors.....		3,546.88	
Tide gauges.....		476.50	
Entrance doors, etc.....		554.73	
Track scales.....		228.12	
Sliding gauges.....		248.97	
Dry dock equipment.....		36.43	
Maintenance of equipment.....		4,324.52	
Division expense.....		9,149.12	
Total division cost.....		295,352.71	
Total division cost main dry dock.....		2,470,791.71	

TABLE NO. 20.—Detailed cost, terminal facilities, Balboa, to June 30, 1916—Continued.

	Quantities.	Amount.	Unit cost.
<b>ENTRANCE PIER.</b>			
<b>Preliminary and general work:</b>	<i>Cubic yards.</i>		
Designs.....		\$5,976.18	
Surveys.....		3,504.85	
Inspection in the United States.....		386.14	
Construction tracks.....		28.61	
Cleaning up.....		825.97	
Division expense.....		1,159.13	
Total division cost.....		11,880.88	
<b>Dry excavation:</b>			
Clearing.....	98,912	8.04	\$0.0001
Drilling.....	98,912	6,797.20	.0687
Blasting.....	98,912	3,591.59	.0363
Excavation by power.....	98,912	7,996.48	.0808
Excavation by hand.....	98,912	60.23	.0006
Tracks.....	98,912	4,998.18	.0505
Transportation.....	98,912	16,661.02	.1684
Dumps.....	98,912	780.81	.0079
Drainage and pumps.....	98,912	3,447.95	.0349
Maintenance of equipment.....	98,912	11,189.82	.1131
Plant arbitrary.....	98,912	15,738.24	.1592
Division expense.....	98,912	2,616.84	.0265
Total division cost.....	98,912	73,886.40	.7470
Less spoil for other divisions.....	2,683	1,341.50	.5000
Net division cost.....		72,544.90	
<b>Preparing foundation:</b>			
Drilling.....	8,427	2,528.96	.3001
Blasting.....	8,427	877.84	.1042
Excavation.....	8,427	10,644.62	1.2632
Tracks.....	8,427	1,364.43	.1619
Transportation.....	8,427	1,386.41	.1645
Drainage and pumps.....	8,427	3,004.26	.3565
Maintenance of equipment.....	8,427	2,101.34	.2494
Division expense.....	8,427	1,721.73	.2042
Total division cost.....	8,427	23,629.59	2.8040
Less spoil for other divisions.....	1,153	864.75	.7500
Net division cost.....		22,764.84	
<b>Concrete masonry, mass:</b>			
Cement.....	16,570	29,496.03	1.7801
Sand.....	16,570	554.10	.0334
Stone.....	16,570	16,366.82	.9877
Mixing.....	16,570	7,305.45	.4409
Forms.....	16,570	11,757.96	.7096
Placing.....	16,570	5,314.93	.3208
Drainage.....	16,570	510.25	.0308
Maintenance of equipment.....	16,570	2,510.25	.1515
Plant arbitrary.....	16,570	3,701.10	.2234
Division expense.....	16,570	2,478.91	.1495
Total division cost.....	16,570	79,995.80	4.8277
<b>Concrete masonry, reinforced:</b>			
Cement.....	2,688	5,908.47	2.1981
Sand.....	2,688	201.42	.0749
Stone.....	2,688	2,776.94	1.0331
Mixing.....	2,688	915.76	.3407
Forms.....	2,688	5,895.15	2.1932
Placing.....	2,688	990.07	.3683
Reinforcements.....	2,688	4,408.96	1.6402
Drainage.....	2,688	164.05	.0610
Maintenance of equipment.....	2,688	689.57	.2565
Plant arbitrary.....	2,688	731.38	.2907
Division expense.....	2,688	976.00	.3632
Total division cost.....	2,688	23,707.77	8.8199
<b>Back filling: Back fill, dumping, and grading.....</b>		127.65	

TABLE NO. 20.—*Detailed cost, terminal facilities, Balboa, to June 30, 1916—Continued.*

	Quantities.	Amount.	Unit cost.
<b>ENTRANCE PIER—continued.</b>			
Miscellaneous:	<i>Cubic yards.</i>		
Structural steel framing..... tons..	493.40	\$25,854.43	\$52.3805
Crane tracks, steel.....		2,097.71	
Anchoring concrete to rock, including drilling.....		8,051.05	
Fender piles.....		6,315.42	
Electric ducts, manholes, and pipes.....		228.60	
Bollards.....		779.05	
Fixed iron and steel.....		678.40	
Piping and valves.....		1,389.87	
Concrete floor slab.....	1.898	16,681.28	8.7889
Tide gauges.....		27.75	
Flooding valves.....		115.30	
Grouting under pressure.....		2,506.76	
Finishing and planting concrete.....		15.54	
Maintenance of equipment.....		1,243.75	
Division expense.....		2,224.42	
Total division cost.....		68,209.33	
Total division cost, entrance pier.....		279,231.17	
<b>COALING PLANT.</b>			
Preliminary and general work:			
Designing.....		10,637.91	
Surveys.....		5,373.16	
Boring and test pits.....		1,064.65	
Clearing.....		82.25	
Inspection in the United States.....		24,636.87	
Division expense.....		2,842.06	
Total division cost.....		44,636.90	
Coal-storage area:			
Dry excavation—			
Clearing.....	190,955	4,128.55	.0216
Drilling.....	190,955	24,547.99	.1285
Blasting.....	190,955	9,562.30	.0501
Excavation.....	190,955	15,520.77	.0813
Excavation by hand.....	190,955	2,708.09	.0142
Tracks.....	190,955	15,279.67	.0800
Transportation.....	190,955	17,619.14	.0923
Dumps.....	190,955	1,186.25	.0062
Drainage and pumps.....	190,955	6,116.14	.0320
Maintenance of equipment.....	190,955	18,265.30	.0957
Plant arbitrary.....	190,955	25,982.88	.1361
Division expense.....	190,955	3,992.90	.0209
Total division cost.....	190,955	144,909.98	.7589
Preparing foundations—			
Drilling.....	1,256	114.93	.0915
Excavation.....	1,256	3,617.06	2.8798
Tracks.....	1,256	2,837.17	2.2589
Drainage and pumps.....	1,256	13.58	.0108
Maintenance of equipment.....	1,256	416.25	.3314
Division expense.....	1,256	675.41	.5377
Total division cost.....	1,256	7,674.40	6.1101
Concrete masonry—			
Cement.....	9,821	11,297.23	1.1503
Stone.....	9,821	5,961.24	.6070
Sand.....	9,821	1,734.41	.1766
Mixing.....	9,821	3,419.90	.3482
Forms.....	9,821	10,074.23	1.0258
Placing.....	9,821	14,868.77	1.5140
Reinforcements in place.....	9,821	4,818.28	.4906
Ladders and fittings.....	9,821	199.33	.0203
Pipe piling.....	9,821	2,093.59	.2132
Drainage and pumps.....	9,821	88.22	.0090
Maintenance of equipment.....	9,821	1,057.11	.1076
Plant arbitrary.....	9,821	1,141.43	.1162
Division expense.....	9,821	3,560.83	.3626
Total division cost.....	9,821	60,314.57	6.1414
Back filling—			
Filling and grading.....	66,338	22,801.82	.3437
Plant arbitrary.....	66,338	300.12	.0059
Division expense.....	66,338	1,263.64	.0191
Total division cost.....	66,338	24,455.58	.3687



TABLE NO. 20.—Detailed cost, terminal facilities, Balboa, to June 30, 1916—Continued.

	Quantities.	Amount.	Unit cost.
COALING PLANT—continued.			
Coal-storage area—Continued.			
Grading floor—	<i>Cubic yards.</i>		
Grading.....		\$2,318.89	
Cleaning up.....		1,556.95	
Drainage.....		5,578.76	
Division expense.....		847.01	
Total division cost.....		10,301.61	
Miscellaneous—			
Piping and valves for fire protection.....		1,626.64	
Tracks.....		9.07	
Total division cost.....		1,635.71	
Total division cost, coal-storage area.....		249,291.85	
Coal-handling plant:			
Foundations for stocking and reclaiming cranes—			
Excavation.....	1,032	4,444.06	\$4.3063
Concrete.....	4,848	37,555.09	7.7465
Reinforcements.....		1,913.40	
Drilling.....		80.31	
Blasting.....		249.75	
Fixed iron.....		875.61	
Tracks, permanent.....		15,533.56	
Back filling.....	499	448.99	.8998
Pile foundations.....		2,425.91	
Maintenance of equipment.....		483.25	
Plant arbitrary.....		789.63	
Division expense.....		3,575.01	
Total division cost.....		68,374.57	
Erection of stocking and reclaiming cranes—			
Berm cranes.....		38,277.00	
Steel erection..... tons.....	1,097.80	29,154.25	26.5570
Alterations.....		31,170.38	
Machinery installation and housing.....		9,387.01	
Electrical installation.....		15,880.01	
Preliminary maintenance.....		4,215.57	
Maintenance of equipment.....		2,537.92	
Division expense.....		5,446.14	
Total division cost.....		136,068.28	
Unloader towers—			
Contract payments.....		147,399.06	
Testing.....		323.25	
Other erection expenses.....		6,069.35	
Division expense.....		364.65	
Total division cost.....		154,156.31	
Reloader towers—			
Contract payments.....		62,167.04	
Testing.....		565.00	
Other erection expenses.....		1,447.12	
Division expense.....		54.74	
Total division cost.....		64,253.90	
Conveyor system—			
Contract payments.....		184,677.35	
Testing.....		565.00	
Other erection expenses.....		34,126.68	
Division expense.....		267.80	
Total division cost.....		219,636.83	
Miscellaneous—track scales.....		1,111.16	
Total division cost, coal-handling plant.....		643,601.05	

TABLE NO. 20.—Detailed cost, terminal facilities, Balboa, to June 30, 1916—Continued.

	Quantities.	Amount.	Unit cost.
SEA WALL AND UNLOADER WHARF.			
Preliminary and general work:	<i>Cubic yards.</i>		
Designing.....		\$2,339.91	
Surveys.....		3,823.11	
Boring and test pits.....		532.32	
Tracks.....		191.67	
Cleaning up.....		1,356.47	
Division expense.....		883.58	
Total division cost.....		9,127.06	
Dry excavation:			
Drilling.....	78,906	14,197.10	\$0.1799
Blasting.....	78,906	6,076.24	.0770
Excavation by power.....	78,906	10,491.19	.1330
Excavation by hand.....	78,906	10,701.96	.1356
Tracks.....	78,906	10,884.09	.1379
Transportation.....	78,906	11,048.41	.1400
Drainage and pumps.....	78,906	5,962.76	.0756
Incline and cofferdam changes.....	78,906	27,577.60	.3495
Maintenance of equipment.....	78,906	9,577.00	.1214
Plant arbitrary.....	78,906	10,697.98	.1356
Division expense.....	78,906	4,859.47	.0616
Total division cost.....	78,906	122,073.80	1.5471
Less spoil for other divisions.....	886	664.50	.7500
Net division cost.....		121,409.30	
Preparing foundation:			
Drilling.....	6,876	682.58	.0993
Blasting.....	6,876	121.82	.0177
Excavation.....	6,876	9,493.72	1.3807
Tracks.....	6,876	183.41	.0267
Transportation.....	6,876	847.19	.1232
Drainage and pumps.....	6,876	2,804.30	.4078
Maintenance of equipment.....	6,876	1,277.05	.1856
Division expense.....	6,876	1,287.86	.1873
Total division cost.....	6,876	16,697.93	2.4283
Less spoil for other divisions.....	1,006	754.50	.7500
Net division cost.....		15,943.43	
Substructure:			
Cylinders—			
Steel cylinders in place.....		2,836.96	
Excavation inside of cylinders.....	257	779.87	3.0345
Pumping.....		54.37	
Maintenance of equipment.....		71.14	
Total.....		3,742.34	
Concrete filling for cylinders.....	158	591.65	3.7447
Reinforcements in cylinders.....	158	275.00	1.7405
Pumping.....	158	10.51	.0665
Maintenance of equipment.....	158	3.29	.0208
Plant arbitrary.....	158	53.72	.3400
Total.....	158	934.17	5.9125
Division expense.....		139.35	
Total division cost.....		4,815.86	
Concrete masonry, mass:			
Cement.....	19,508	35,828.98	1.8367
Sand.....	19,508	195.80	.0100
Stone.....	19,508	16,153.11	.8280
Mixing.....	19,508	8,075.61	.4140
Forms.....	19,508	18,025.66	.9240
Placing.....	19,508	7,332.16	.3759
Reinforcements.....	19,508	1,133.97	.0581
Drainage and pumps.....	19,508	404.42	.0207
Maintenance of equipment.....	19,508	1,518.51	.0778
Plant arbitrary.....	19,508	3,747.05	.1921
Division expense.....	19,508	3,456.30	.1772
Total division cost.....	19,508	95,871.57	4.9145

TABLE NO. 20.—Detailed cost, terminal facilities, Balboa, to June 30, 1916—Continued.

	Quantities.	Amount.	Unit cost.
SEA WALL AND UNLOADER WHARF—continued.			
Concrete masonry, reinforced:	<i>Cubic yards.</i>		
Cement.....	2,619	\$5,885.99	\$2.2474
Sand.....	2,619	265.65	.1014
Stone.....	2,619	2,517.47	.9612
Mixing.....	2,619	1,152.98	.4402
Forms.....	2,619	6,681.64	2.5512
Placing.....	2,619	998.32	.3812
Reinforcements.....	2,619	5,714.45	2.1819
Drainage and pumps.....	2,619	132.10	.0504
Maintenance of equipment.....	2,619	708.21	.2704
Plant arbitrary.....	2,619	605.17	.2312
Division expense.....	2,619	1,158.59	.4424
Total division cost.....	2,619	25,820.57	9.8589
Miscellaneous:			
Structural steel..... tons.....	758.71	34,930.37	46.0392
Concrete covering beams and girders.....	3,364	23,983.70	7.1295
Tracks and fastenings.....		6,585.62	
Fenders.....		8,744.21	
Bollards and cleats.....		1,557.70	
Anchors and deadmen.....		4,843.19	
Riprap.....		1,001.30	
Piping.....		1,341.14	
Back fill.....	14,966	10,958.46	.7322
Ladders and fittings.....		199.33	
Electric ducts, manholes, and pipes.....		702.55	
Maintenance of equipment.....		836.88	
Plant arbitrary.....		655.07	
Division expense.....		2,974.84	
Total division cost.....		99,314.36	
Total division cost, sea wall and unloader wharf.....		372,302.15	
RELOADER WHARF.			
Preliminary and general work:			
Designs.....		6,708.61	
Surveys.....		4,740.08	
Clearing.....		1,852.24	
Testing material.....		15.61	
Dredging under quay.....		6,907.19	
Construction tracks.....		3,515.83	
Construction trestles and pile supports.....		30,590.39	
Cleaning up.....		1,187.98	
Division expense.....		3,201.03	
Total division cost.....		58,718.96	
Substructure:			
Cylinders—			
Steel cylinders in place.....		77,612.20	
Excavation inside of cylinders.....	7,124	14,301.51	2.0075
Pumping.....		5,545.42	
Maintenance of equipment.....		9,785.53	
Total.....		107,244.66	
Concrete filling for cylinders.....	6,182	24,641.35	3.9860
Reinforcement in cylinders.....	6,182	15,941.80	2.5787
Pumping.....	6,182	1,866.42	.3019
Maintenance of equipment.....	6,182	1,332.66	.2156
Plant arbitrary.....	6,182	2,059.88	.3332
Total.....	6,182	45,842.11	7.4154
Division expense.....		5,045.01	
Total division cost.....		158,131.78	
Superstructure:			
Structural steel decking..... tons.....	1,560.35	82,021.01	52.5658
Reinforced concrete slab.....	4,757	43,515.04	9.1686
Maintenance of equipment.....		1,001.57	
Plant arbitrary.....		1,617.04	
Division expense.....		2,443.18	
Total division cost.....		130,697.84	

TABLE NO. 20.—Detailed cost, terminal facilities, Balboa, to June 30, 1916—Continued.

	Quantities.	Amount.	Unit cost.
<b>RELOADER WHARF—continued.</b>			
Filling:	<i>Cubic yards.</i>		
Back filling.....	10,589	\$5,670.42	\$0.5355
Riprapping.....	1,658	1,621.05	.9777
Maintenance of equipment.....	12,247	287.90	.0235
Plant arbitrary.....	12,247	1,906.02	.1556
Division expense.....	12,247	335.17	.0274
Total division cost.....	12,247	9,820.56	.8019
Miscellaneous:			
Tracks and fastenings.....		3,512.28	
Fenders.....		6,251.96	
Bollards and cleats.....		759.17	
Anchors.....		66,250.91	
Piping and valves.....		3,033.72	
Electric ducts, manholes, and pipes.....		1,404.70	
Tide gauges.....		32.03	
Maintenance of equipment.....		1,637.88	
Division expense.....		3,179.77	
Total division cost.....		86,062.42	
Total division cost, reloader wharf.....		443,431.56	
Total division cost, coaling station.....		1,753,263.51	
<b>PERMANENT SHOPS.</b>			
Miscellaneous.....		587,079.27	
Steel erection.....		34,508.77	
Machine and erection shop.....		623,885.35	
Forge shop.....		214,868.80	
Steel storage shed.....		115,111.01	
Boiler and shipfitters' shop.....		220,615.12	
General storehouse.....		291,679.26	
Paint shop.....		55,866.08	
Car shop.....		97,040.75	
Planing mill.....		192,509.14	
Galvanizing building.....		55,519.44	
Lumber and equipment shed.....		116,079.98	
Pattern storage room.....		57,983.65	
Foundry.....		253,956.61	
Coke shed.....		10,208.63	
Boiler house.....		24,457.73	
Roundhouse.....		154,654.36	
Gas house.....		20,181.47	
Toilets.....		82,854.91	
Paint house.....		10,753.73	
Main office.....		198,146.70	
Sand house.....		12,395.81	
Compressor plant and pump house.....		152,437.88	
Lye house.....		2,592.65	
Ice-storage house.....		656.90	
Shop tunnel.....		155,613.16	
Total division cost.....		3,741,657.06	
<b>DOCKS.</b>			
Quay wall, north of concrete dock:			
Preliminary work.....		11,193.88	
Substructure.....		182,030.90	
Superstructure.....		210,522.36	
Miscellaneous.....		38,926.42	
Total division cost.....		442,673.56	
Quay wall, south of concrete dock:			
Preliminary work.....		40,714.39	
Dredging.....		12,059.60	
Substructure.....		226,077.04	
Superstructure.....		143,273.79	
Miscellaneous.....		54,777.40	
Total division cost.....		476,902.22	
Bulkhead quay wall, between wharf and Pier No. 1:			
Preliminary work.....		12,301.33	
Substructure.....		69,981.21	
Superstructure.....		58,331.13	
Miscellaneous.....		79,270.64	
Total division cost.....		219,884.34	

TABLE NO. 20.—Detailed cost, terminal facilities, Balboa, to June 30, 1916—Continued.

	Quantities.	Amount.	Unit cost.
<b>DOCKS—continued.</b>			
Pier No. 1:	<i>Cubic yards.</i>		
Preliminary work.....		\$32,874.60	
Substructure.....		353,215.48	
Superstructure.....		277,722.13	
Pier shed.....		210,459.73	
Miscellaneous.....		154,127.40	
Total division cost.....		1,028,399.34	
Concrete lumber wharf.....		256,622.33	
Electrical installation.....		7,966.52	
Water mains.....		7,162.62	
Air mains.....		3,389.93	
Total division cost, all docks.....		2,443,000.86	
<b>FUEL-OIL-HANDLING PLANT.</b>			
<b>Storage:</b>			
United States tanks Nos. 3 and 4—			
Surveys.....		194.61	
Tracks.....		53.15	
Tank foundations.....		2,422.71	
Contract price.....		31,405.14	
Concrete gutters and aprons.....		2,212.36	
Fire walls.....		6,836.72	
Painting.....		1,933.10	
Miscellaneous pipe-line connections.....		1,093.64	
Miscellaneous charges.....		213.64	
Design and supervision.....		617.93	
Total division cost.....		46,983.00	
United States tank No. 5—			
Tracks.....		38.12	
Tank foundation.....		302.42	
Tank erection.....		7,049.93	
Fire walls.....		2,453.06	
Pipe-line connections.....		150.95	
Design and supervision.....		609.55	
Total division cost.....		10,604.03	
Tank farm—			
Preparing site.....		616.97	
Surveys.....		909.47	
Water mains.....		3,584.49	
Fencing.....		538.32	
Drainage.....		7,422.54	
Gravel walks.....		1,060.62	
Design and supervision.....		1,014.61	
Total division cost.....		15,147.02	
Oil-pump plant:			
Boiler and pump house—			
General.....		1,294.93	
Design and supervision.....		2,803.74	
Structure.....		10,758.81	
Concrete drains and sewers.....		1,268.35	
Machinery foundations.....		1,514.06	
Cost of equipment.....		17,977.85	
Brick setting.....		3,555.24	
Installation, boiler and stack.....		2,087.69	
Installation, auxiliary apparatus.....		6,713.05	
Installation, steam and water fittings.....		1,692.06	
Installation, oil pumps.....		3,297.53	
Electrical installation.....		1,993.70	
Manifold—			
Foundation.....		3,370.10	
Installation.....		15,915.89	
Valve indicators.....		82.59	
Total division cost.....		74,325.59	

TABLE NO. 20.—Detailed cost, terminal facilities, Balboa, to June 30, 1916—Continued.

	Quantities.	Amount.	Unit cost.
<b>FUEL-OIL-HANDLING PLANT—continued.</b>			
Oil docks:	<i>Cubic yards.</i>		
Design and supervision.....		\$907.55	
Preliminary and general work.....		6,951.05	
Substructure.....		27,138.82	
Superstructure.....		8,150.11	
Miscellaneous.....		990.76	
Oil-boat anchorage.....		14,785.36	
Total division cost.....		58,923.65	
Pipe lines:			
Installation, 6-inch line, crib to pumping plant.....		1,711.16	
Installation, 10-inch line, crib to pumping plant.....		14,304.20	
Installation, 10-inch line, pumping plant to French steel pier.....		3,875.76	
Installation, 10-inch line to reloader wharf.....		51.86	
Installation, 12-inch lines.....		8,115.34	
Installation, pipe line to Paraiso.....		46,241.26	
Total division cost.....		74,299.58	
Dredging berth for ships.....		7,933.40	
Total division cost, oil-fuel storage.....		288,216.27	
Gasoline storage:			
Tank foundation.....		486.23	
Tank.....		5,706.93	
Housing.....		2,979.23	
Pipe lines.....		1,506.79	
Fencing.....		337.25	
Fire walls.....		396.41	
Design and supervision.....		76.14	
Total division cost, gasoline storage.....		11,488.98	
Total division cost, oil-fuel and gasoline storage.....		299,705.25	
Unabsorbed plant, Balboa terminals.....		122,226.20	
Total division cost, Balboa terminal facilities.....		14,101,188.22	

TABLE NO. 21.—Detailed cost, permanent townsites, to June 30, 1916.

Item.	La Boca.	Balboa.	Pedro Miguel.	Gatun.	Cristobal.
Preliminary and general work.....	\$37,557.50	\$176,171.18	\$32,688.82		
Preliminary maintenance.....		10,519.78			
Road construction.....	31,869.40	321,171.40	20,777.72		
Drainage.....	14,842.53	7,903.21	22,488.65		
Waterworks.....	20,779.72	46,607.78	19,597.24		
Sewer system.....	26,328.15	171,587.04	11,572.72		
Walks.....	6,084.34	36,482.30	281.62		
Balboa nursery.....		1,576.79			
Lot improvements.....		210,835.27		\$3.75	
Street lighting.....		28,119.30	6,463.05	4,892.46	\$5,296.73
Underground duct system.....		116,042.65	3,267.45	11,006.55	52,092.18
Improvements, block A.....	10,221.73				
Division expense.....	4,440.38	39,180.78	2,355.67		
Total division cost.....	152,123.75	1,196,197.48	119,492.94	15,902.76	57,388.91

TABLE No. 22.—Detail of "Buildings" to June 30, 1916.

		Amount.
Designing and preliminary expenses, new buildings		\$16,079.62
Administration building, Balboa Heights		932,415.16
Administration building, Santa Rosa		127,960.85
Paraiso shops, appraisal of old building		2,800.00
Storehouses:		
Oil storehouse, Balboa	\$31,067.22	
Forage storehouse	6,140.66	
Explosives storehouse	461.14	
Dredge parts storehouse	4,720.32	
Oil storehouse, Cristobal	5,800.00	
Electrical storehouse, Balboa	2,156.79	
Electrical storehouse, Gatun	1,911.50	
Appraisal of old buildings	86,357.07	138,614.70
Hotels and mess halls:		
Hotel Aspinwall landing stage	1,897.34	
Cristobal hotel	4,804.31	
Gatun mess hall	1,759.13	
La Boca mess hall	7,386.39	
La Boca kitchen	2,606.67	
Appraisal of old buildings	245,443.00	263,896.84
Gold quarters:		
Four-family concrete quarters	1,066,094.73	
Two-family concrete quarters	177,536.86	
Bachelor concrete quarters	69,139.25	
New wooden quarters	187,105.81	
Reerected wooden quarters	238,533.25	
Appraisal of old buildings	1,381,015.09	3,119,424.99
Silver quarters:		
New wooden quarters	42,330.37	
Reerected wooden quarters	196,059.28	
Appraisal of old buildings	136,837.97	375,227.62
Hospitals:		
Colon hospital	176,617.66	
Ancon hospital	180,800.70	357,418.36
Dispensaries:		
Balboa dispensary	16,677.79	
Pedro Miguel dispensary	300.00	16,977.79
Asylums:		
Corozal asylum buildings	72,782.28	
Dairy shed	23,562.45	
Dairy building	12,546.53	
Hog shed	8,237.88	
Compost pit	537.75	
Appraisal of Palo Seco buildings	37,925.46	155,592.35
Quarantine stations:		
Balboa quarantine station	38,756.88	
Balboa quarantine landing	26,078.40	64,835.28
Medical storehouse, Ancon		22,393.93
Post offices:		
Corozal	1,592.62	
Appraisal of old buildings	34,390.00	35,982.62
Schoolhouses:		
Concrete white school, Balboa	334.44	
Manual-training school, Balboa	4,611.85	
Concrete white school, Cristobal	240.44	
Appraisal of old buildings	69,515.00	74,701.73
Courthouses, fire and police stations, etc.:		
La Boca fire station	280.22	
Balboa fire station	18,335.31	
Balboa police station	11,190.59	
Appraisal of old buildings	60,635.44	90,441.56
Fluviographs		11,534.38
Terminal office building, Balboa		70,594.76

TABLE NO. 22.—*Detail of "Buildings" to June 30, 1916—Continued.*

	Amount.
Miscellaneous buildings:	
Balboa clubhouse.....	\$17,481.20
Pedro Miguel clubhouse.....	19,695.77
Cristobal clubhouse.....	16,000.00
Gatun clubhouse, silver employees.....	1,500.00
La Boca clubhouse.....	3,989.62
Balboa motor-car house.....	11,448.16
Garages, Ancon-Balboa district.....	22,432.78
Garage, Cristobal.....	817.18
Office and storeroom, Ancon.....	1,035.04
Office, store, and shop, district quartermaster, Balboa Heights.....	15,184.33
Anemometer tower, Balboa Heights.....	1,747.69
Boathouse, marine division, piers 1-2, Colon.....	1,887.41
Boathouse, marine division, pier 18, Balboa.....	1,656.48
Five small buildings.....	845.17
Corozal cemetery.....	2,113.77
La Boca lodge hall.....	1,689.23
Office and storeroom, Pedro Miguel.....	311.56
Appraisal of old buildings.....	112,207.26
	<b>\$232,042.65</b>
Total buildings.....	<b>6,108,935.19</b>

TABLE NO. 23.—*Detailed statement of classified expenditures in health department for the fiscal year 1916, and from the beginning of the work to date.*

	Fiscal year 1916.	Total to June 30, 1915.	Grand total.
Administration.....	( <sup>1</sup> )	\$899,223.30	\$899,223.30
Hospitals and asylums:			
Medical storehouse.....	( <sup>1</sup> )	52,793.87	52,793.87
Ancon hospital.....	\$145,347.63	4,194,141.79	4,339,489.42
Colon hospital.....	33,128.76	1,995,294.75	2,028,423.51
Taboga sanitarium.....		131,428.43	131,428.43
Santo Tomas hospital.....	11,136.23	83,579.69	94,715.92
Other hospitals, dispensaries, and sick camps.....	50,434.11	2,247,573.87	2,298,007.98
Quarantine.....	27,362.13	440,349.73	467,711.86
Sanitation, Panama.....	37,210.16	880,988.26	918,198.42
Sanitation, Colon.....	26,925.69	658,635.64	685,561.33
Street cleaning and garbage disposal, Panama.....	15,224.65	105,936.83	121,161.48
Street cleaning and garbage disposal, Colon.....	13,428.91	58,179.48	71,608.39
Zone sanitation.....	171,118.59	4,359,687.93	4,530,806.52
Street cleaning and garbage disposal, Zone.....		553,809.73	553,809.73
Construction of buildings.....	( <sup>2</sup> )	1,037,745.06	1,037,745.06
Repairs of buildings.....	( <sup>3</sup> )	125,594.40	125,594.40
Corozal farm.....	20,986.87	28,296.93	49,283.80
Total.....	552,303.73	17,853,259.69	18,405,563.42

<sup>1</sup> "Administration" and "Medical storehouse" were prorated to other units of health department after December, 1914.

<sup>2</sup> Construction of health department buildings was charged to "Buildings" beginning July, 1914.

<sup>3</sup> Repairs of buildings was prorated to other units of health department this year.



TABLE NO. 24.—Panama Canal—Operations, health department, fiscal year 1916.

	Quantity.	Cost.	Unit cost.
<b>ANCON HOSPITAL.</b>			
Division expense.....		\$19,858.41	
Superintendent's office.....		15,362.62	
Admitting office.....		4,169.88	
Chaplains.....		2,429.77	
Hospital cars and ambulances.....		5,129.19	
Quartermaster's department.....		7,215.75	
Operation of motor trucks.....		2,538.87	
Repairs to buildings and equipment.....		6,888.05	
Total general expense.....		63,592.54	
Operation of drug store.....		13,144.94	
Steam plant.....		3,472.13	
Linen room.....		12,254.90	
Kitchen.....		13,801.57	
Bakery.....pounds, bread.....	231,103	7,564.10	\$0.0327
Gold mess.....rations.....	31,898	26,075.59	.8175
Silver mess.....do.....	59,261	10,142.03	.1711
Dispensary:			
Direct expenses.....		12,013.81	
General expenses.....		4,132.50	
Total.....		16,146.31	
Clinics:			
Direct expenses.....		6,631.62	
General expenses.....		3,232.91	
Total.....		9,864.53	
X-ray department:			
Direct expenses.....examinations.....	722	1,762.87	2.4694
General expenses.....do.....	722	176.53	.2445
Total.....do.....	722	1,959.40	2.713
Undertaking:			
Direct expenses.....		6,183.76	
General expenses.....		1,416.18	
Total.....		7,599.94	
Operating room:			
Direct expenses.....operations.....	3,003	18,698.89	6.2268
General expenses.....do.....	3,003	4,170.11	1.3886
Total.....do.....	3,003	22,869.00	7.6154
Operating room, eye and ear:			
Direct expenses.....do.....	577	3,162.76	5.4814
General expenses.....do.....	577	1,132.99	1.9636
Total.....do.....	577	4,295.75	7.4450
<b>Ward treatment.</b>			
Section A, white, male, surgical:			
Direct expenses.....patient days.....	22,921	19,517.14	.8515
Subsistence.....do.....	22,921	13,366.34	.5832
General expenses.....do.....	22,921	6,482.41	.2828
Total.....do.....	22,921	39,365.89	1.7175
Section B, black, male, surgical:			
Direct expenses.....do.....	45,026	20,371.58	.4524
Subsistence.....do.....	45,026	9,158.14	.2035
General expenses.....do.....	45,026	6,661.05	.1479
Total.....do.....	45,026	36,190.77	.8038
Section C, white, medical:			
Direct expenses.....do.....	6,091	16,149.04	2.6513
Subsistence.....do.....	6,091	4,804.17	.7887
General expenses.....do.....	6,091	5,945.27	.9761
Total.....do.....	6,091	26,898.48	4.4161

TABLE NO. 24.—*Panama Canal—Operations, health department, fiscal year 1916—Contd.*

	Quantity.	Cost.	Unit cost.
ANCON HOSPITAL—continued.			
Ward treatment—continued.			
Section D, eye and ear:			
White ward—			
Direct expenses.....patient days.....	4,793	\$4,428.06	\$ .9239
Subsistence.....do.....	4,793	3,196.70	.6670
General expenses.....do.....	4,793	1,459.98	.3045
Total.....do.....	4,793	9,084.74	1.8954
Black ward—			
Direct expenses.....do.....	6,051	5,366.76	.8869
Subsistence.....do.....	6,051	1,293.53	.2138
General expenses.....do.....	6,051	1,881.24	.3109
Total.....do.....	6,051	8,541.53	1.4116
Total section D.....do.....	10,844	17,626.27	1.6254
Section E, black female:			
Direct expenses.....do.....	18,866	15,176.83	.8042
Subsistence.....do.....	18,866	4,650.50	.2464
General expenses.....do.....	18,866	5,078.18	.2695
Total.....do.....	18,866	24,905.51	1.3201
Section F, male, medical:			
White wards—			
Direct expenses.....do.....	14,154	10,540.24	.7447
Subsistence.....do.....	14,154	9,488.93	.6704
General expenses.....do.....	14,154	3,638.15	.2570
Total.....do.....	14,154	23,667.32	1.6721
Black wards—			
Direct expenses.....do.....	38,319	19,879.44	.5188
Subsistence.....do.....	38,319	9,773.36	.2551
General expenses.....do.....	38,319	6,932.74	.1788
Total.....do.....	38,319	36,505.54	.9527
Total section F.....do.....	52,473	60,172.86	1.1467
Section G, white, female:			
Ward—			
Direct expenses.....do.....	4,715	10,634.44	2.2554
Subsistence.....do.....	4,715	3,816.05	.8093
General expenses.....do.....	4,715	3,642.61	.7726
Total.....do.....	4,715	18,093.10	3.8373
Private rooms—			
Direct expenses.....do.....	3,776	11,429.50	3.0269
Subsistence.....do.....	3,776	3,074.72	.8143
General expenses.....do.....	3,776	4,079.35	1.0803
Total.....do.....	3,776	18,583.57	4.9215
Nursery—			
Direct expenses.....do.....	2,339	4,416.46	1.8882
General expenses.....do.....	2,339	1,517.25	.6487
Total.....do.....	2,339	5,933.71	2.5369
Total section G.....do.....	10,830	42,610.38	3.9345
Chronics:			
Direct expenses.....do.....	10,163	676.00	.0665
Subsistence.....do.....	10,163	1,739.13	.1712
General expenses.....do.....	10,163	201.50	.0198
Total.....do.....	10,163	2,616.63	.2575
Ward 17, isolation:			
Direct expenses.....do.....	3,763	6,155.69	1.6359
Subsistence.....do.....	3,763	2,106.88	.5599
General expenses.....do.....	3,763	1,891.59	.5026
Total.....do.....	3,763	10,154.16	2.6984
Total ward treatment.....do.....	180,977	260,540.95	1.4396
Physical examination of employees.....		276.15	
Mess, boarders.....		8,880.42	
Total expenses, Ancon Hospital.....		332,432.45	

TABLE NO. 24.—Panama Canal—Operations, health department, fiscal year 1916—Contd.

	Quantity.	Cost.	Unit cost.
<b>COLON HOSPITAL.</b>			
Division expense.....		\$2,839.84	
Superintendent's office.....		4,917.33	
Ambulance.....		1,594.72	
Repairs to buildings and equipment.....		3,721.63	
Total general expense.....		13,073.52	
Kitchen.....		2,950.52	
Dispensary:			
Direct expenses.....		7,607.39	
General expense.....		3,379.52	
Total.....		10,986.91	
Operating room:			
Direct expenses..... operations..	390	3,645.83	\$9.3483
General expense..... do.....	390	1,646.99	4.2230
Total..... do.....	390	5,292.82	13.5713
<b>Ward treatment.</b>			
White patients:			
Direct expenses..... patient days..	6,544	7,604.47	1.1620
Subsistence..... do.....	6,544	5,238.45	.8005
General expense..... do.....	6,544	3,806.61	.5817
Total..... do.....	6,544	16,649.53	2.5442
Black patients:			
Direct expenses..... do.....	7,347	8,527.32	1.1607
Subsistence..... do.....	7,347	2,217.02	.3017
General expense..... do.....	7,347	4,240.40	.5772
Total..... do.....	7,347	14,984.74	2.0396
Total ward treatment..... do.....	13,891	31,634.27	2.2773
Mess, boarders.....		942.55	
Total expenses, Colon Hospital.....		48,856.55	
<b>COROZAL HOSPITAL.</b>			
Division expense.....		3,408.41	
Superintendent's office.....		3,591.63	
Total general expense.....		7,000.04	
Kitchen.....		19,192.59	
Mess..... rations..	27,216	6,993.03	.2569
Sewing room.....		3,824.76	
Linen room, laundry, etc.....		953.56	
Care of insane:			
Direct expenses..... patient days..	98,000	25,809.86	.2634
Subsistence..... do.....	98,000	13,363.80	.1364
General expense..... do.....	98,000	3,832.34	.0390
Total..... do.....	98,000	43,006.00	.4388
Operation of farm:			
Farm.....		8,243.62	
Dairy..... quarts milk..	81,108	13,291.45	.1639
Poultry..... dozen eggs..	2,280	1,687.57	.7402
Purchase of fowls.....		935.53	
Piggery.....		2,372.90	
Care of cemetery.....		1,305.58	
General expense.....		3,167.70	
Total operation of farm.....		31,004.35	
Mess, boarders.....		825.47	
Total operation of hospital and farm.....		74,835.82	
Credits:			
Produce transferred to other departments.....		440.10	
Produce transferred to health department.....		13,907.79	
Produce sold to commissary department.....		949.83	
Produce sold to outsiders.....		5,817.63	
Total credits.....		21,115.35	
Net expenses, Corozal hospital and farm.....		53,720.47	

TABLE NO. 24.—Panama Canal—Operations, health department, fiscal year 1916—Contd.

	Quantity.	Cost.	Unit cost.
<b>SANTO TOMAS HOSPITAL.</b>			
Direct expenses.....		\$11,136.23	
<b>PALO SECO LEPER ASYLUM.</b>			
Direct expenses.....patient days.....	20,995	22,439.57	\$1.0688
Division expense.....do.....	20,995	831.28	.0396
Total.....do.....	20,995	23,270.85	1.1084
<b>OTHER HOSPITALS AND DISPENSARIES.</b>			
Naos Island.....		404.91	
Balboa.....		13,275.51	
Corozal.....		2,578.46	
Pedro Miguel.....		5,571.21	
Paraiso.....		7,193.33	
Gamboa.....		1,929.42	
Gatun.....		8,371.15	
Toro Point.....		333.22	
District dentists.....		717.33	
Culebra.....		234.29	
Division expense.....		4,037.52	
Total.....		44,646.35	
<b>QUARANTINE.</b>			
Division expense.....		2,521.08	
Chief quarantine office.....		2,100.42	
Total general expense.....		4,621.50	
Quarantine proper, Balboa:			
Direct expenses.....		10,369.72	
General expense.....		1,020.05	
Total.....		11,389.77	
Maintenance of passengers, Balboa:			
Direct expenses.....quarantine days.....	4,602	12,111.01	2.6317
General expense.....do.....	4,602	854.28	.1856
Total.....do.....	4,602	12,965.29	2.8173
Quarantine proper, Colon:			
Direct expenses.....		18,131.36	
General expense.....		1,814.39	
Total.....		19,945.75	
Maintenance of passengers, Colon:			
Direct expenses.....quarantine days.....	8,623	16,723.88	1.9395
General expense.....do.....	8,623	932.78	.1081
Total.....do.....	8,623	17,656.66	2.0476
Total expenses, quarantine.....		61,957.47	
<b>SANITATION, PANAMA.</b>			
Direct expenses.....		45,270.59	
Division expense.....		2,253.14	
Total.....		47,523.73	
<b>STREET CLEANING, PANAMA.</b>			
Direct expenses.....		50,506.77	
Division expense.....		2,717.88	
Total.....		53,224.65	
Total sanitation, Panama.....		100,748.38	
<b>SANITATION, COLON.</b>			
Direct expenses.....		36,392.60	
Division expense.....		2,016.97	
Total.....		38,409.57	

TABLE NO. 24.—*Panama Canal—Operations, health department, fiscal year 1916—Contd.*

	Quantity.	Cost.	Unit cost.
STREET CLEANING, COLON.			
Direct expenses.....		\$26,135.16	
Division expense.....		1,166.35	
Total.....		27,301.51	
Total sanitation, Colon.....		65,711.08	
SANITATION, ZONE.			
Balboa.....		23,656.38	
Ancon.....		26,924.11	
Corozal.....		16,678.93	
Pedro Miguel.....		38,384.99	
Frijoles.....		1,029.58	
Gatun.....		41,264.19	
Mount Hope, Cristobal.....		27,323.79	
Culebra.....		55.86	
Division expense.....		4,863.09	
Total sanitation, Zone.....		180,180.92	
SUMMARY.			
Administration.....		9,319.94	
Board of health laboratory.....		20,695.81	
Operation of medical storehouse.....		14,056.94	
Reserve for new tools.....		2,441.28	
Total division expense.....		46,513.97	
Ancon Hospital.....		332,432.45	
Colon Hospital.....		48,856.55	
Santo Tomas Hospital.....		11,136.23	
Palo Seco Leper Asylum.....		23,270.85	
Corozal Hospital.....		74,835.82	
Other hospitals and dispensaries.....		44,646.35	
Quarantine.....		61,957.47	
Sanitation, Panama.....		47,523.73	
Sanitation, Colon.....		38,409.57	
Sanitation, Zone.....		180,180.92	
Street cleaning, Panama.....		53,224.65	
Street cleaning, Colon.....		27,301.51	
Total expenses, health department.....		943,776.10	
Cost of services to outsiders.....		375,273.46	
Net expenses, health department.....		568,502.64	

TABLE NO. 25A.—*Dredging excavation—Detailed cost per unit of work, by months, fiscal year 1916.*

## ATLANTIC ENTRANCE—CONSTRUCTION.

Item.	July.		Total.	
	Quantities.	Unit cost.	Quantities.	Unit cost.
	<i>Cubic yards.</i>		<i>Cubic yards.</i>	
Operation, pipe-line dredges.....	20,746	\$0.0609	20,746	\$0.0609
Repairs, pipe-line dredges.....	20,746	.0378	20,746	.0378
Operation, miscellaneous floating equipment.....	20,746	.0170	20,746	.0170
Repairs, miscellaneous floating equipment.....	20,746	.0075	20,746	.0075
Channel lights.....	20,746	.0009	20,746	.0009
Division expense.....	20,746	.0082	20,746	.0082
Total division cost.....	20,746	.1323	20,746	.1323
Earth excavation..... per cent.....	20,746	100.00	20,746	100.00



TABLE No. 25c.—*Dredging excavation—Detailed cost per unit of work, by months, fiscal year 1916.*

## MIRAFLORES LAKE—CONSTRUCTION.

Item.	May.		June.		Total.	
	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.
Operation, pipe-line dredges.....	Cubic yards, 10,050	\$0.1735	Cubic yards, 8,552	\$0.0917	Cubic yards, 18,602	\$0.1359
Repairs, pipe-line dredges.....	10,050	.1280	8,552	.0705	18,602	.1016
Depreciation, pipe-line dredges.....	10,050	.0339	8,552	.0071	18,602	.0107
Operation, miscellaneous floating equipment.....	10,050	.0034	8,552	.....	18,602	.0018
Repairs, miscellaneous floating equipment.....	10,050	.0013	8,552	.....	18,602	.0007
Depreciation, miscellaneous floating equipment.....	10,050	.0002	8,552	.....	18,602	.0001
Pipe lines.....	10,050	.0094	8,552	.....	18,602	.0051
Division expense.....	10,050	.0158	8,552	.0193	18,602	.0175
Total division cost.....	10,050	.3456	8,552	.1886	18,602	.2734
Earth excavation.....	10,050	100.00	8,552	100.00	18,602	100.00
..... per cent..						

TABLE No. 25D.—*Dredging excavation—Detailed cost per unit of work, by months, fiscal year 1916.*

## PACIFIC ENTRANCE—CONSTRUCTION.

Item.	July.		August.		September.		February.		May.		Total.	
	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.
Operation, small ladder dredges.....	<i>Cubic yards.</i> 16, 506	\$0. 1480	<i>Cubic yards.</i> 10, 778	\$0. 1290	<i>Cubic yards.</i> 8, 303	\$0. 0882	<i>Cubic yards.</i> 3, 163	.....	<i>Cubic yards.</i> 3, 750	.....	<i>Cubic yards.</i> 35, 587	\$0. 1283
Repairs, small ladder dredges.....	16, 506	.1047	10, 778	.1051	8, 303	.0838	3, 163	.....	9, 374	.....	35, 587	.1000
Operation, pipe-line dredges.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Repairs, pipe-line dredges.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Depreciation, pipe-line dredges.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Operation, tugs, clapnets, and scoops.....	16, 506	.0819	10, 778	.0598	8, 303	.0390	3, 163	.0580	9, 374	.0793	12, 537	.0739
Repairs, tugs, clapnets, and scoops.....	16, 506	.0190	10, 778	.0383	8, 303	.0006	3, 163	.0055	9, 374	.0153	12, 537	.0128
Operation, drill barge.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Repairs, drill barge.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Depreciation, drill barge.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Operation, rock breaker.....	16, 329	.0622	.....	.....	8, 303	.0838	.....	.....	3, 750	.1513	39, 160	.1324
Repairs, rock breaker.....	16, 329	.0235	.....	.....	8, 303	.0128	.....	.....	3, 750	.2198	39, 160	.2703
Depreciation, rock breaker.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Operation, miscellaneous floating equipment.....	16, 506	.0039	10, 778	.0039	8, 303	.0022	3, 163	.0033	9, 374	.0287	39, 160	.2116
Repairs, miscellaneous floating equipment.....	16, 506	.0005	10, 778	.0026	8, 303	.0003	3, 163	.0002	9, 374	.0050	39, 160	.3167
Depreciation, miscellaneous floating equipment.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Blasting.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pipe lines.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Channel lights.....	16, 506	.0014	10, 778	.0012	8, 303	.0009	3, 163	.0014	9, 374	.0009	12, 537	.0012
Division expense.....	16, 506	.0014	10, 778	.0135	8, 303	.0466	3, 163	.0438	9, 374	.1591	48, 124	.0050
Total division cost.....	16, 506	.4984	10, 778	.3834	8, 303	.3582	3, 163	.3916	9, 374	2. 2448	48, 124	2. 2610
Earth excavation.....	177	1. 07	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rock excavation.....	16, 329	98. 93	10, 778	100. 00	8, 303	100. 00	3, 163	100. 00	5, 624	60. 00	8, 964	18. 63
.....do.....	.....	.....	.....	.....	.....	.....	.....	.....	3, 750	40. 00	39, 160	81. 37



TABLE No. 26A.—*Dredging excavation—Detailed cost per unit of work, by months, fiscal year 1916.*

## ATLANTIC ENTRANCE—OPERATION AND MAINTENANCE.

Item.	July.		Total.	
	Quantities.	Unit cost.	Quantities.	Unit cost.
Operation, pipe-line suction dredges.....	<i>Cubic yards.</i> 24, 715	\$0. 0422	<i>Cubic yards.</i> 24, 715	\$0. 0422
Repairs, pipe-line suction dredges.....	24, 715	.0262	24, 715	.0262
Operation, miscellaneous floating equipment.....	24, 715	.0156	24, 715	.0156
Repairs, miscellaneous floating equipment.....	24, 715	.0069	24, 715	.0069
Channel lights.....	24, 715	.0009	24, 715	.0009
Division expense.....	24, 715	.0207	24, 715	.2646
Total division cost.....	24, 715	.1125	24, 715	.3564
Earth excavation.....	24, 715	100. 00	24, 715	100. 00
		.....per cent.		

TABLE No. 26B.—*Dredging excavation—Detailed cost per unit of work, by months, fiscal year 1916.*

## GAILLARD CUT—OPERATION AND MAINTENANCE.

Item.	July.		August.		September.		October.		November.		December.	
	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.
Operation, seagoing suction dredges.....	<i>Cubic yards.</i> 139, 394	\$0. 0600	<i>Cubic yards.</i> 132, 639	\$0. 0645	<i>Cubic yards.</i> 121, 131	\$0. 0725	<i>Cubic yards.</i> 119, 973	\$0. 0857	<i>Cubic yards.</i> 94, 921	\$0. 1063	<i>Cubic yards.</i> 105, 002	\$0. 1001
Repairs, seagoing suction dredges.....	139, 394	.0408	132, 639	.0515	121, 131	.0505	119, 973	.0448	94, 921	.0606	105, 002	.0557
Depreciation, seagoing suction dredges.....	139, 394	.0129	132, 639	.0155	121, 131	.0143	119, 973	.0181	94, 921	.0229	105, 002	.0207
Operation, small ladder dredges.....	650	.7052	.....	.....	15, 040	.0804	75, 671	.0733	36, 615	.0818	15, 720	.0688
Repairs, small ladder dredges.....	650	.4032	.....	.....	15, 040	.0408	75, 671	.0353	36, 615	.0337	15, 720	.0286
Depreciation, small ladder dredges.....	650	.0143	.....	.....	15, 040	.0026	75, 671	.0032	36, 615	.0093	15, 720	.0187
Operation, 3-yard ladder dredges.....	.....	.....	140, 519	.0607	106, 901	.0711	91, 985	.0713	141, 500	.0605	91, 656	.0517
Repairs, 3-yard ladder dredges.....	.....	.....	140, 519	.0953	106, 901	.1104	91, 985	.0452	141, 500	.1027	91, 656	.0917
Depreciation, 3-yard ladder dredges.....	.....	.....	140, 519	.0142	106, 901	.0187	91, 985	.0435	141, 500	.0283	91, 656	.0436
Operation, small dipper dredges.....	109, 014	.0578	136, 692	.0618	171, 388	.0613	162, 374	.0539	6, 315	.0626	.....	.....

TABLE No. 26B.—*Dredging excavation—Detailed cost per unit of work, by months, fiscal year 1916—Continued.*

GAILLARD CUT—OPERATION AND MAINTENANCE—Continued.

Item.	July.		August.		September.		October.		November.		December.	
	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.
Repairs, small dipper dredges.....	<i>Cubic yards.</i> 109, 014	\$0. 0979	<i>Cubic yards.</i> 136, 692	\$0. 0712	<i>Cubic yards.</i> 171, 388	\$0. 0750	<i>Cubic yards.</i> 162, 374	\$0. 0974	<i>Cubic yards.</i> 6, 315	\$0. 2002	<i>Cubic yards.</i> .....	.....
Depreciation, small dipper dredges.....	109, 014	.0012	136, 692	.0011	171, 388	.0008	162, 374	.0035	6, 315	.0413	.....	.....
Operation, large dipper dredges.....	341, 430	.0450	403, 240	.0401	501, 490	.0310	541, 885	.0312	820, 050	.0322	900, 455	\$0. 0206
Repairs, large dipper dredges.....	341, 430	.0568	403, 240	.0567	501, 490	.0388	541, 885	.0390	820, 050	.0362	900, 455	.0220
Operation, large dipper dredges.....	341, 430	.0076	403, 240	.0064	501, 490	.0052	541, 885	.0129	820, 050	.0128	900, 455	.0117
Depreciation, pipe-line suction dredges.....	28, 991	.0514	112, 561	.0343	22, 609	.1168	87, 805	.0774	129, 329	.0564	43, 260	.1701
Repairs, pipe-line suction dredges.....	28, 991	.0288	112, 561	.0188	22, 609	.0670	87, 805	.0396	129, 329	.0299	43, 260	.1264
Operation, pipe-line suction dredges.....	28, 991	.0165	112, 561	.0112	22, 609	.0362	87, 805	.0100	129, 329	.0068	43, 260	.0202
Depreciation, tugs, clapsels, and scows.....	451, 094	.0854	680, 451	.0664	794, 819	.0639	871, 915	.0665	1, 004, 480	.0579	1, 007, 831	.0596
Repairs, tugs, clapsels, and scows.....	451, 094	.0515	680, 451	.0571	794, 819	.0412	871, 915	.0240	1, 004, 480	.0563	1, 007, 831	.0421
Depreciation, tugs, clapsels, and scows.....	451, 094	.0297	680, 451	.0222	794, 819	.0169	871, 915	.0151	1, 004, 480	.0134	1, 007, 831	.0131
Operation, drill barges.....	451, 094	.0063	680, 451	.0053	794, 819	.0029	871, 915	.....	1, 004, 480	.....	1, 007, 831	.0025
Repairs, drill barges.....	451, 094	.0024	680, 451	.0010	794, 819	.0028	871, 915	.....	1, 004, 480	.....	1, 007, 831	.0002
Operation, drill barges.....	451, 094	.0004	680, 451	.0001	794, 819	.0007	871, 915	.....	1, 004, 480	.....	1, 007, 831	.0002
Repairs, hydraulic graders.....	619, 479	.0049	925, 651	.0033	938, 559	.0021	1, 079, 693	.0015	1, 228, 730	.0012	1, 156, 093	.0019
Depreciation, hydraulic graders.....	619, 479	.0002	925, 651	.0002	938, 559	.0001	1, 079, 693	.0005	1, 228, 730	.0004	1, 156, 093	.0005
Operation, hydraulic graders.....	619, 479	.0007	925, 651	.0007	938, 559	.0007	1, 079, 693	.0005	1, 228, 730	.0004	1, 156, 093	.0005
Depreciation, hydraulic graders.....	619, 479	.0077	925, 651	.0061	938, 559	.0053	1, 079, 693	.0055	1, 228, 730	.0053	1, 156, 093	.0057
Operation, miscellaneous floating equipment.....	619, 479	.0032	925, 651	.0034	938, 559	.0033	1, 079, 693	.0035	1, 228, 730	.0038	1, 156, 093	.0040
Repairs, miscellaneous floating equipment.....	619, 479	.0013	925, 651	.0009	938, 559	.0009	1, 079, 693	.0008	1, 228, 730	.0006	1, 156, 093	.0007
Depreciation, miscellaneous floating equipment.....	619, 479	.0036	925, 651	.0033	938, 559	.0033	1, 079, 693	.0033	1, 228, 730	.0033	1, 156, 093	.0033
Drilling.....	451, 094	.0036	680, 451	.0033	794, 819	.0144	871, 915	.0101	1, 017, 413	.0090	1, 007, 831	.0067
Blasting.....	451, 094	.0036	680, 451	.0033	794, 819	.0051	871, 915	.0013	1, 017, 413	.0048	1, 007, 831	.0021
Pipe lines.....	28, 991	.0045	112, 561	.0046	22, 609	.0121	87, 805	.0175	129, 329	.0540	43, 260	.0320
Operation, relay pumps.....	28, 991	.0275	112, 561	.0124	22, 609	.0153	87, 805	.0244	129, 329	.0207	43, 260	.0031
Repairs, relay pumps.....	28, 991	.0097	112, 561	.0001	22, 609	.0006	87, 805	.0003	1, 228, 730	.0038	1, 156, 093	.0034
Channel lights.....	619, 479	.0004	925, 651	.0003	938, 559	.0006	1, 079, 693	.0013	1, 228, 730	.0009	1, 156, 093	.0074
Shuicing.....	.....	.....	.....	.....	.....	.....	1, 079, 693	.0272	1, 228, 730	.0238	1, 156, 093	.0239
Division expense.....	619, 479	.0175	925, 651	.0183	938, 559	.0219	1, 079, 693	.2538	1, 228, 730	.2724	1, 156, 093	.2657
Total division cost.....	619, 479	.2920	925, 651	.2783	938, 559	.2766	1, 079, 693	.....	1, 228, 730	.....	1, 156, 093	.....
Earth excavation.....per cent.....	168, 385	27. 18	245, 200	26. 49	143, 740	15. 31	207, 778	19. 24	211, 317	17. 20	148, 262	12. 82
Rock excavation.....do.....	451, 094	72. 82	680, 451	73. 51	794, 819	84. 69	871, 915	80. 76	1, 017, 413	82. 80	1, 007, 831	87. 18
Rehanded yardage not credited to excavation: Small ladder dredges.....	.....	.....	.....	.....	.....	.....	500	.....	.....	.....	100, 939	.....
Pipe line suction dredges.....	.....	.....	.....	.....	63, 076	.....	91, 235	.....	37, 994	.....	.....	.....

## GAILLARD CUT—MAINTENANCE.

Item.	January.		February.		March.		April.		May.		June.		Total.	
	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.
Operation, seagoing suction dredges....	Cu. yds. 88,273	\$0.1161	Cu. yds. 7,316	\$0.9390	Cu. yds. 89,665	\$0.0941	Cu. yds. 37,371	\$0.0803	Cu. yds. 13,108	\$0.0755	Cu. yds. 948,793	\$0.0896		
Repairs, seagoing suction dredges....	88,273	.0652	7,316	.5310	89,665	.0543	37,371	.0487	13,108	.0545	948,793	.0640		
Depreciation, seagoing suction dredges....	88,273	.0246	7,316	.2106	89,665	.0201	37,371	.0180	13,108	.0248	948,793	.0216		
Operation, small ladder dredges....	12,340	.0736			26,840	.1059	9,840	.2171	7,205	.0508	229,921	.0674		
Repairs, small ladder dredges....	12,340	.0253			26,840	.0327	9,840	.0718	7,205	.0246	229,921	.0402		
Depreciation, small ladder dredges....	12,340	.0073			26,840	.0005	9,840	.0008	7,205	.0040	229,921	.0063		
Operation, 3-yard ladder dredges....	12,340	.0583	\$0.0542	.0630	70,333	.0892	138,600	.0725	123,166	.0724	1,415,090	.0663		
Repairs, 3-yard ladder dredges....	171,870	.0403	.0571	.0588	70,333	.1703	138,600	.0683	123,166	.0693	1,415,090	.0759		
Depreciation, 3-yard ladder dredges....	171,870	.0233	.0222	.0252	70,333	.0569	138,600	.0289	123,166	.0325	1,415,090	.0283		
Operation, small dipper dredges....	37,545	.0597									623,328	.0589		
Repairs, small dipper dredges....	37,545	.0460									623,328	.0387		
Depreciation, small dipper dredges....	37,545	.0098									623,328	.0026		
Operation, large dipper dredges....	721,045	.0331			912,286	.0297	742,426	.0356	894,440	.0290	8,901,822	.0325		
Repairs, large dipper dredges....	721,045	.0388			912,286	.0360	742,426	.0423	894,440	.0343	8,901,822	.0389		
Depreciation, large dipper dredges....	721,045	.0146			912,286	.0115	742,426	.0141	894,440	.0117	8,901,822	.0116		
Operation, pipe-line suction dredges....					64,552	.1436	105,444	.1139	53,652	.3273	63,052	.2612		
Repairs, pipe-line suction dredges....					64,552	.0774	105,444	.0642	53,652	.1808	63,052	.1921		
Depreciation, pipe-line suction dredges....					64,552	.0165	105,444	.0138	53,652	.0333	63,052	.0300		
Operation, tugs, clapnets, and scoops....	972,800	.0570	1,039,950	.0584	1,077,591	.0543	916,184	.0660	1,080,486	.0534	10,984,029	.0612		
Repairs, tugs, clapnets, and scoops....	972,800	.0424	1,039,950	.0413	1,077,591	.0393	916,184	.0431	1,080,486	.0381	10,984,029	.0436		
Depreciation, tugs, clapnets, and scoops....	972,800	.0134	1,039,950	.0125	1,077,591	.0116	916,184	.0145	1,080,486	.0121	10,984,029	.0147		
Operation, drill barges....	972,800	.0071	1,039,950	.0087	1,084,738	.0094	850,143	.0080			10,805,874	.0036		
Repairs, drill barges....	972,800	.0006	1,039,950	.0012	1,084,738	.0003	850,143	.0017			10,805,874	.0008		
Depreciation, drill barges....	972,800	.0030	1,039,950	.0034	1,142,834	.0042	1,034,708	.0056	1,133,903	.0049	12,430,209	.0034		
Operation, hydraulic graders....	1,061,073	.0008	1,039,950	.0016	1,142,834	.0008	1,034,708	.0008	1,133,903	.0003	12,430,209	.0006		
Repairs, hydraulic graders....	1,061,073	.0005	1,039,950	.0006	1,142,834	.0005	1,034,708	.0005	1,133,903	.0005	12,430,209	.0005		
Depreciation, hydraulic graders....					27,927	.0059	1,034,708	.0063	1,133,903	.0055	12,430,209	.0038		
Operation, miscellaneous floating equipment....	1,061,073	.0059	1,039,950	.0059	1,142,834	.0045	1,034,708	.0063	1,133,903	.0055	12,430,209	.0038		
Repairs, miscellaneous floating equipment....	1,061,073	.0023	1,039,950	.0061	1,142,834	.0009	1,034,708	.0037	1,133,903	.0023	12,430,209	.0037		
Depreciation, miscellaneous floating equipment....	1,061,073	.0007	1,039,950	.0007	1,142,834	.0006	1,034,708	.0007	1,133,903	.0007	12,430,209	.0007		
Drilling....	972,800	.0192	1,039,950	.0145	1,084,738	.0108	850,143	.0089	1,035,040	.0065	999,680	.0024		
Blasting....	972,800	.0026	1,039,950	.0027	1,084,738	.0022	850,143	.0073	1,035,040	.0024	999,680	.0008		
Pipe lines....					27,927	.1140	28,859	.0398	16,046	.2388	497,387	.0765		
Operation, relay pumps....					27,927	.0594	28,859	.0325	16,046	.1291	497,387	.0297		

1 Includes credit.

TABLE No. 26b.—*Dredging excavation—Detailed cost per unit of work, by months, fiscal year 1916—Continued.*

## GAILLARD CUT—MAINTENANCE—Continued.

Item.	January.		February.		March.		April.		May.		June.		Total.	
	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.	Quantities.	Unit cost.
	<i>Cu. yds.</i>		<i>Cu. yds.</i>		<i>Cu. yds.</i>		<i>Cu. yds.</i>		<i>Cu. yds.</i>		<i>Cu. yds.</i>		<i>Cu. yds.</i>	
Repairs, relay pumps.....	1,061,073	\$0.0003	1,039,950	\$0.0003	1,142,834	\$0.0226	28,859	\$0.0311	16,046	\$0.0417	1,069,536		497,387	\$0.0120
Channel lights.....	1,061,073		1,039,950		1,142,834	.0003	1,034,708		1,133,903	.0006	1,069,536		12,430,209	.0003
Sluicing.....	1,061,073	.0009	1,039,950	.0019	1,142,834	.0007	1,034,708	.0006	1,133,903	.0075	1,069,536		12,430,209	.0013
Division expense.....	1,061,073	.0230	1,039,950	.0240	1,142,834	.0188	1,034,708	.0298	1,133,903	.0300	1,069,536		12,430,209	.0246
Total division cost.....	1,061,073	.2898	1,039,950	.3082	1,142,834	.2614	1,034,708	.3073	1,133,903	.2766	1,069,536		12,430,209	.2806
Earth excavation.....per cent.	88,273	8.32			58,096	5.08	184,565	17.84	98,863	8.72	69,856	6.53	1,624,335	13.07
Rock excavation.....do.....	972,800	91.68	1,039,950	100.00	1,084,738	94.92	850,143	82.16	1,035,040	91.28	999,680	93.47	10,805,874	86.93
Rebanded rdage not dited to excavation:														
Seagoing suction dredges.....	4,022		110,128		86,754								200,904	
Small ladder dredges.....	3,770		24,766						6,400				35,436	
Pipeline suction dredges.....	45,325		88,542		19,893				173,273		102,191		722,468	
Small dipper dredges.....	475								520				995	
Material pumped into barges by pipe-line suction dredges.....					36,625		76,355		37,606		63,032		213,868	



TABLE NO. 27.—*Panama Canal—Gamboa gravel production—Detailed cost per unit of work, by months, fiscal year 1916.*

Item.	July.	August.	Septem-ber.	October.	Novem-ber.	Decem-ber.	January.	Febru-ary.	March.	April.	May.	June.	Total.
Quantities.....cubic yards..	39,163	40,740	45,120	43,641	41,405	42,686	44,261	49,093	64,885	59,309	54,487	54,358	579,148
Unloading from barges.....	\$0.0175	\$0.0192	\$0.0202	\$0.0289	\$0.0311	\$0.0580	\$0.0365	\$0.0291	\$0.0333	\$0.0354	\$0.0400	\$0.0312	\$0.0372
Switching.....	.0364	.0377	.0348	.0306	.0473	.0375	.0257	.0320	.0308	.0351	.0346	.0262	.0345
Hoisting.....	.0008	.0007	.0007	.0007	.0007	.0012	.0007	.0006	.0005	.0005	.0006	.0006	.0006
Storing.....	.0132	.0183	.0110	.0205	.0036	.0290	.0136	.0033	.0058	.0050	.0063	.0001	.0102
Repairs to equipment.....	.0833	.0247	.0457	.0240	.0188	.0162	.0228	.0159	.0614	.0433	.0279	.0315	.0400
Dredging and towing.....	.4074	.3176	.2890	.3053	.2839	.3190	.3397	.2994	.2287	.1736	.2737	.2620	.2818
Miraflores storage pile.....	.....	.0008	.0017	.....	.0012	.....	.....	.0007	.0025	.....	.....	.....	.0006
Plant arbitrary.....	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000	.1000
Division expense.....	.0096	.0089	.0092	.0126	.0091	.0146	.0126	.0123	.0114	.0154	.0196	.0171	.0130
Total division cost.....	.7002	.5509	.5313	.5226	.5257	.5665	.5616	.4933	.4744	.4083	.5021	.4771	.5179

TABLE No. 28.—Panama Canal—Detail of cost of production and distribution of electric current for fiscal year 1916.

	July.	August.	September.	October.	November.	December.
<b>Power plants:</b>						
Gatun hydroelectric.....	\$2, 076. 41	\$2, 259. 33	\$2, 165. 01	\$1, 876. 20	\$2, 140. 93	\$2, 027. 61
Gatun steam.....	449. 40	311. 59	3, 174. 82	158. 17	167. 14	167. 99
Miraflores steam.....	3, 794. 30	3, 239. 04	3, 282. 19	3, 956. 82	3, 963. 31	3, 316. 03
Reserve for depreciation.....	8, 000. 00	8, 000. 00	8, 000. 00	8, 000. 00	8, 000. 00	8, 000. 00
<b>Total production cost.....</b>	<b>14, 320. 11</b>	<b>13, 809. 96</b>	<b>13, 622. 02</b>	<b>13, 991. 19</b>	<b>14, 271. 38</b>	<b>14, 011. 63</b>
<b>Substations:</b>						
Cristobal.....	729. 52	1, 032. 60	815. 85	841. 96	805. 41	944. 39
Gatun.....	894. 95	1, 095. 20	934. 53	1, 035. 76	889. 30	884. 13
Miraflores.....	1, 435. 66	1, 782. 23	1, 780. 14	1, 421. 69	1, 341. 17	1, 192. 00
Balboa.....	758. 47	1, 479. 13	1, 083. 29	708. 94	755. 53	924. 64
<b>Transmission lines:</b>						
Cristobal to Gatun.....	214. 28	244. 53	269. 81	261. 87	317. 32	238. 57
Miraflores to Balboa.....	107. 24	139. 42	142. 42	148. 18	187. 85	103. 68
Gatun to Miraflores.....	1, 679. 71	1, 474. 67	1, 438. 05	1, 594. 55	1, 801. 94	1, 079. 25
Distribution line expense.....	3, 068. 57	1, 639. 03	1, 073. 21	265. 72	2, 177. 53	3, 062. 35
<b>Cost of current distributed.....</b>	<b>23, 208. 51</b>	<b>22, 696. 77</b>	<b>21, 111. 32</b>	<b>20, 269. 86</b>	<b>22, 547. 43</b>	<b>22, 440. 64</b>
<b>K. w. hours distributed.....</b>	<b>2, 522, 195</b>	<b>2, 683, 143</b>	<b>2, 721, 078</b>	<b>2, 805, 006</b>	<b>2, 644, 683</b>	<b>2, 663, 697</b>
<b>Cost per k. w. hour:</b>						
Production.....	\$0. 0057	\$0. 0051	\$0. 0050	\$0. 0050	\$0. 0054	\$0. 0052
Current distributed.....	. 0092	. 0085	. 0077	. 0072	. 0085	. 0084

TABLE No. 28.—Panama Canal—Detail of cost of production and distribution of electric current for fiscal year 1916—Continued.

	January.	February.	March.	April.	May.	June.	Total.
<b>Powerplants:</b>							
Gatun hydroelectric.....	\$1,953.58	\$1,985.02	\$1,944.82	\$2,080.00	\$2,470.00	\$2,103.23	\$25,082.14
Gatun steam.....	80.31	80.91					1,605.33
Miraflores steam.....	3,747.45	3,370.14	3,036.39	4,506.58	4,283.81	3,667.72	44,663.78
Reserve for depreciation.....	8,600.00	8,600.00	8,600.00	8,600.00	8,600.00	8,600.00	96,000.00
<b>Total production cost.....</b>	<b>13,787.34</b>	<b>13,445.07</b>	<b>12,981.21</b>	<b>14,586.58</b>	<b>14,753.81</b>	<b>13,770.95</b>	<b>167,351.25</b>
<b>Substations:</b>							
Cristobal.....	946.19	975.78	988.71	948.87	1,047.03	904.56	10,980.87
Gatun.....	783.91	795.43	801.93	1,030.89	971.61	897.10	11,014.74
Miraflores.....	1,783.87	1,089.04	1,156.84	1,193.35	1,203.02	1,138.01	15,875.02
Balboa.....	881.94	800.60	793.30	1,056.23	816.04	804.03	10,812.14
<b>Transmission lines:</b>							
Cristobal to Gatun.....	401.25	283.03	174.16	410.54	192.85	194.76	3,185.97
Miraflores to Balboa.....	208.36	44.99	69.68	149.98	67.28	128.06	1,497.14
Gatun underground.....		199.93	82.31	13.26	19.58		315.08
Gatun to Miraflores.....	1,098.27	1,146.66	1,568.18	1,339.27	2,427.82	1,077.44	17,425.81
Distribution line expense.....	2,327.83	2,252.32	2,568.17	2,595.66	2,648.07	2,088.71	25,799.17
<b>Cost of current distributed.....</b>	<b>21,576.96</b>	<b>21,042.85</b>	<b>21,187.49</b>	<b>23,324.63</b>	<b>23,847.11</b>	<b>21,003.62</b>	<b>264,257.19</b>
<b>K.w. hours distributed.....</b>	<b>2,673,071</b>	<b>2,652,649</b>	<b>3,521,572</b>	<b>2,896,148</b>	<b>3,317,344</b>	<b>3,086,175</b>	<b>34,186,761</b>
<b>Cost per k.w. hour:</b>							
Production.....	\$0.0052	\$0.0051	\$0.0037	\$0.0050	\$0.0044	\$0.0045	\$0.0049
Current distributed.....	.0081	.0079	.0060	.0081	.0072	.0068	.0077



TABLE NO. 29.—*Panama Canal—Cost of water per 1,000 gallons, fiscal year 1916, Ancon-Balboa-Panama system.*

[Quantities exclude water used in City of Panama and north of Pedro Miguel.]

	Quantity, 1,000 gallons.	Operation Gamboa pump station.	Operation Mirafleres filtration plant.	Operation Balboa pump station.	Mainte- nance water mains.	Total.
<b>1915.</b>						
July.....	124,649	\$0.0158	\$0.0153	\$0.0130	<sup>1</sup> \$0.0012	\$0.0429
August.....	110,429	.0144	.0134	.0138	.0235	.0651
September.....	111,506	.0167	.0153	.0204	.0149	.0673
October.....	133,986	.0119	.0135	.0117	.0128	.0499
November.....	127,755	.0146	.0136	.0097	.0079	.0453
December.....	115,455	.0139	.0126	.0125	.0148	.0538
<b>1916.</b>						
January.....	114,902	.0152	.0146	.0109	.0339	.0746
February.....	99,928	.0134	.0222	.0116	.0340	.0812
March.....	108,400	.0138	.0108	.0112	.0432	.0790
April.....	107,456	.0096	.0121	.0097	.0170	.0484
May.....	120,493	.0128	.0152	.0115	.0195	.0590
June.....	145,874	.0098	.0227	.0104	.0075	.0504
Total.....	1,420,833	.0134	.0151	.0121	.0181	.0587

<sup>1</sup> Indicates credit.TABLE NO. 30.—*Panama Canal—Cost of water per 1,000 gallons, fiscal year 1916, Gatun system.*

	Quantity, 1,000 gallons.	Mainte- nance Agua Clara reservoir.	Operation Agua Clara filtration plant.	Operation Agua Clara pump station.	Mainte- nance water mains.	Total.
<b>1915.</b>						
July.....	20,431	\$0.0262	\$0.0463	\$0.0526	\$0.0145	\$0.1396
August.....	20,135	.0248	.0926	.0546	.0096	.1816
September.....	21,114	.0266	.0733	.0736	.0220	.1955
October.....	22,127	.0311	.0492	.0492	.0181	.1476
November.....	20,463	.0278	.0460	.0659	.0215	.1612
December.....	23,168	.0322	.0297	.0480	.0199	.1298
<b>1916.</b>						
January.....	22,068	.0339	.0605	.0478	.0236	.1658
February.....	20,867	.0354	.0383	.0594	.0214	.1545
March.....	20,786	.0497	.0310	.0517	.0196	.1520
April.....	21,763	.0643	.0515	.0476	.0268	.1902
May.....	19,225	.1285	.0387	.0602	.0263	.2537
June.....	19,650	.1380	.0742	.0563	.0299	.2984
Total.....	251,797	.0504	.0523	.0554	.0211	.1792

TABLE NO. 31.—*Panama Canal—Cost of water per 1,000 gallons, fiscal year 1916, Colon-Cristobal system.*

[Quantities exclude water used in City of Colon.]

	Quantity, 1,000 gallons.	Mainte- nance Brazos Brook Reservoir.	Operation Mount Hope filtration plant.	Operation Mount Hope pump station.	Mainte- nance water mains.	Total.
1915.						
July.....	78,098	\$0.0061	\$0.0078	\$0.0154	\$0.0165	\$0.0458
August.....	77,365	.0052	.0092	.0138	.0241	.0523
September.....	74,946	.0054	.0059	.0146	.0185	.0444
October.....	59,218	.0061	.0091	.0138	.0367	.0657
November.....	57,523	.0078	.0080	.0153	.0365	.0676
December.....	54,059	.0086	.0098	.0156	.0295	.0635
1916.						
January.....	60,011	.0071	.0122	.0154	.0330	.0677
February.....	55,562	.0086	.0148	.0155	.0377	.0766
March.....	61,020	.0042	.0137	.0161	.0239	.0579
April.....	59,426	.0055	.0102	.0166	.0368	.0691
May.....	60,909	.0047	.0127	.0207	.0477	.0853
June.....	55,819	.0072	.0136	.0166	.0460	.0834
Total.....	733,956	.0063	.0105	.0158	.0313	.0639

TABLE NO. 32.—*Cost of operating employees' quarters, fiscal year 1916.*

## GOLD AND SILVER QUARTERS.

	July.	August.	September.	October.	November.	December.
<b>Gold, family:</b>						
Grass cutting.....	\$2,034.79	\$1,533.62	\$406.02	\$821.57	\$688.62	\$654.36
Disposal of garbage.....	591.67	605.45	465.75	509.37	553.63	534.40
Care of grounds.....	1,752.76	3,185.19	4,624.70	2,743.96	2,502.39	2,157.83
Repairs to furniture.....	2,300.44	2,830.99	2,898.43	2,829.25	2,296.33	2,190.12
Repairs to refrigerators.....	1,291.79	1,010.41	870.95	916.93	1,179.81	889.45
Repairs to stoves.....	1,014.69	1,129.47	1,070.09	1,043.21	827.89	1,025.61
Corral service.....	1,022.65	1,452.26	1,665.56	1,759.71	2,001.88	1,945.43
Utility service.....	470.64	916.94	908.62	761.40	685.23	546.18
Division expense.....	971.22	1,220.24	1,114.24	1,067.00	898.71	1,123.79
Repairs to buildings.....	10,952.53	12,581.71	10,638.91	11,233.17	7,749.38	8,616.42
Total division cost.....	22,403.18	26,496.28	24,663.27	23,685.57	19,383.87	19,992.59
<b>Gold, bachelor:</b>						
Grass cutting.....	401.13	299.06	50.40	267.20	102.22	155.21
Disposal of garbage.....	137.69	128.58	93.59	97.24	103.61	88.27
Care of grounds.....	416.53	993.67	1,341.54	878.58	765.13	644.56
Repairs to furniture.....	327.60	256.72	186.85	273.69	323.95	462.25
Janitor service.....	2,991.00	3,080.62	2,951.61	3,027.84	3,073.14	3,042.34
Corral service.....	316.42	390.80	341.79	319.88	593.67	545.24
Utility service.....	490.65	332.52	317.19	310.16	243.25	245.48
Division expense.....	726.00	785.69	634.42	695.66	725.57	795.04
Repairs to buildings.....	3,120.79	2,743.54	1,919.01	1,816.43	3,055.67	3,064.80
Total division cost.....	8,927.81	9,011.20	8,036.40	7,686.68	8,986.21	9,043.19
Total division cost, gold quarters.....	31,330.99	35,507.48	32,699.67	31,372.25	28,370.08	29,035.78
<b>Silver, family:</b>						
Grass cutting.....	537.27	75.31	15.75	88.25	39.15	65.02
Disposal of garbage.....	186.52	170.47	149.41	164.17	181.85	237.39
Care of grounds.....	191.43	148.49	134.25	86.50	113.68	133.29
Corral service.....	221.94	229.62	229.52	323.48	340.39	318.68
Electric lights.....	273.36	266.19	227.76	206.32	206.61	254.27
Division expense.....	112.55	204.66	176.99	178.65	165.27	171.16
Repairs to buildings.....	941.06	275.95	551.14	598.32	3,156.73	1,470.87
Total division cost.....	2,464.13	1,370.69	1,484.82	1,645.69	4,203.68	2,650.68
<b>Silver, bachelor:</b>						
Grass cutting.....	313.98	20.36	5.10	68.97	26.75	51.75
Disposal of garbage.....	109.16	95.10	84.48	77.78	88.25	74.98
Care of grounds.....	141.19	183.88	123.26	165.41	172.80	182.48
Corral service.....	281.48	251.91	117.74	109.02	160.39	133.87
Electric lights.....	103.81	112.58	87.75	79.59	79.70	97.80
Repairs to furniture.....	106.70	72.67	27.39	345.58	.40	5.17
Janitor service.....	988.82	995.21	987.90	1,079.92	994.60	1,014.24
Division expense.....	223.25	228.60	191.65	242.62	240.86	250.93
Repairs to buildings.....	385.21	482.00	524.07	551.65	764.35	1,189.31
Total division cost.....	2,653.60	2,442.31	2,149.34	2,720.54	2,528.10	3,090.53
Total division cost, sil- ver quarters.....	5,117.73	3,813.00	3,634.16	4,366.23	6,731.78	5,651.21
Total division cost, all quarters.....	36,148.72	39,320.48	36,333.83	35,738.48	35,101.86	34,686.99

TABLE No. 32.—*Cost of operating employees' quarters, fiscal year 1916—Continued.*

## GOLD AND SILVER QUARTERS—Continued.

	January.	February.	March.	April.	May.	June.	Total.
<b>Gold, family:</b>							
Grass cutting.....	\$362.19	\$429.21	\$564.59	\$393.37	\$1,025.87	\$391.44	\$9,305.65
Disposal of garbage.....	504.89	541.12	584.19	500.50	506.25	420.22	6,317.44
Care of grounds.....	1,974.86	1,158.45	1,661.96	1,440.65	1,613.04	1,791.50	26,607.29
Repairs to furniture.....	2,165.96	2,263.64	2,062.54	2,263.45	1,766.11	2,544.95	28,721.21
Repairs to refrigerators.....	1,245.31	834.13	1,116.49	1,072.47	1,195.38	1,369.83	12,992.95
Repairs to stoves.....	1,070.75	692.13	1,256.54	824.42	493.78	781.95	11,230.53
Corral service.....	1,752.45	1,529.23	1,908.33	1,363.30	1,442.62	1,596.71	19,440.13
Utility service.....	465.86	387.85	447.78	410.20	509.23	478.20	7,018.13
Division expense.....	988.73	745.60	692.50	791.45	843.79	750.54	11,207.81
Repairs to buildings.....	5,619.48	3,722.00	3,315.08	4,008.35	5,005.34	4,281.61	87,724.08
Total division cost.....	16,150.48	12,303.36	13,610.00	13,068.26	14,401.41	14,406.95	220,565.22
<b>Gold, bachelor:</b>							
Grass cutting.....	51.60	47.69	92.89	44.54	123.63	47.27	1,682.84
Disposal of garbage.....	87.67	79.97	98.41	93.32	59.08	77.46	1,144.89
Care of grounds.....	481.87	305.75	329.89	320.42	326.36	421.58	7,225.88
Repairs to furniture.....	362.19	323.67	127.36	135.59	207.09	270.35	3,257.31
Janitor service.....	2,814.66	3,108.32	3,083.52	3,021.44	2,852.51	3,070.43	36,117.43
Corral service.....	489.55	432.07	401.96	350.34	432.04	465.91	5,079.67
Utility service.....	206.88	173.35	204.60	157.60	153.95	176.20	3,011.83
Division expense.....	711.20	706.06	598.90	739.04	663.72	746.75	8,728.05
Repairs to buildings.....	636.20	600.12	598.55	914.68	772.90	723.53	19,966.22
Total division cost.....	5,841.82	5,777.00	5,536.08	5,776.97	5,591.28	5,999.48	86,214.12
Total division cost, gold quarters.....	21,992.30	18,080.36	19,146.08	18,845.23	19,992.69	20,406.43	306,779.34
<b>Silver, family:</b>							
Grass cutting.....	\$15.25	.....	\$14.20	.....	\$43.21	\$5.00	\$898.41
Disposal of garbage.....	232.14	\$233.47	221.25	\$221.32	220.35	117.52	2,335.86
Care of grounds.....	196.89	135.24	162.80	129.95	181.85	163.56	1,777.93
Corral service.....	281.38	262.00	426.62	150.93	190.25	171.19	3,146.00
Electric lights.....	353.67	354.63	230.47	243.34	280.20	270.00	3,166.82
Division expense.....	169.07	163.16	165.26	171.21	182.28	163.81	2,024.07
Repairs to buildings.....	1,129.47	1,254.06	1,641.06	891.34	1,597.86	1,504.82	15,012.68
Total division cost.....	2,377.87	2,402.56	2,861.66	1,808.09	2,696.00	2,395.90	28,361.77
<b>Silver, bachelor:</b>							
Grass cutting.....	10.75	.....	11.90	.....	16.24	4.00	529.80
Disposal of garbage.....	72.44	59.79	67.06	63.37	58.58	48.49	899.48
Care of grounds.....	157.65	94.65	140.13	77.89	114.41	92.11	1,645.86
Corral service.....	100.33	85.23	52.22	38.32	47.57	38.39	1,416.47
Electric lights.....	87.54	82.95	56.74	60.23	69.37	66.91	984.97
Repairs to furniture.....	.....	66	.....	.....	1.98	4.18	564.73
Janitor service.....	996.10	987.13	1,144.08	1,046.78	1,109.43	1,160.86	12,505.07
Division expense.....	243.68	251.01	260.26	263.55	266.37	275.97	2,938.55
Repairs to buildings.....	436.97	538.69	565.15	87.11	598.97	1,302.92	7,426.40
Total division cost.....	2,105.46	2,100.11	2,297.54	1,637.05	2,282.92	2,993.83	28,911.33
Total division cost, silver quarters.....	4,483.33	4,502.67	5,159.20	3,445.14	4,978.92	5,389.73	57,273.10
Total division cost, all quarters.....	26,475.63	22,583.03	24,305.28	22,290.37	24,971.61	25,796.16	364,052.44

## COST OF COAL AND KINDLING WOOD FURNISHED GOLD MARRIED QUARTERS.

July.....	\$4,179.31
August.....	4,282.00
September.....	3,339.27
October.....	3,752.17
November.....	4,452.60
December.....	4,523.16
January.....	4,878.09
February.....	4,608.95
March.....	4,005.45
April.....	4,461.65
May.....	4,827.61
June.....	5,412.53
Total.....	52,725.79

TABLE No. 32.—*Cost of operating employees' quarters, fiscal year 1916*—Continued.

## COST OF ELECTRIC CURRENT FURNISHED GOLD QUARTERS.

July.....	\$3,522.30
August.....	2,672.84
September.....	2,461.82
October.....	2,463.26
November.....	3,061.10
December.....	3,248.65
January.....	3,540.92
February.....	2,423.82
March.....	2,599.48
April.....	2,971.40
May.....	2,896.33
June.....	3,044.06
Total.....	34,905.98

TABLE No. 33.—Statement of appropriation, receipts, and disbursements for fiscal year ending June 30, 1916.

	Receipts.				Total available.	Expenditures.			Cash balance June 30, 1916.
	Cash balance July 1, 1915.	Acts of Feb. 28, 1916.	Collections.	Transfers between departments.		Disbursements.	Transfers between departments.	Total.	
Canal connecting Atlantic and Pacific Oceans.....	\$804,992.99	.....	.....	.....	\$804,992.99	\$35,253.17	\$2,390.74	\$97,643.91	\$707,349.08
Panama Canal fund.....	4,855,025.96	.....	\$1,343,741.59	.....	6,198,767.55	4,925,263.63	55,550.44	4,980,814.07	1,217,953.48
Construction and equipment.....	10,500,000.00	.....	411,246.25	.....	10,911,246.25	2,963,720.97	4,884,487.66	7,848,208.63	3,063,037.62
Maintenance and operation.....	5,200,000.00	.....	5,187,262.40	\$6,624,139.87	17,011,402.27	15,722,930.13	.....	15,722,930.13	1,288,472.14
Sanitation, Canal Zone.....	700,000.00	.....	248,613.42	.....	948,613.42	701,654.22	145,705.98	847,360.20	101,253.22
Civil government, Panama Canal and Canal Zone.....	540,000.00	.....	29,454.52	.....	569,454.52	444,302.94	59,475.39	503,778.33	65,676.19
Total.....	22,600,018.95	.....	7,220,318.18	6,624,139.87	36,444,477.00	24,853,125.06	5,147,610.21	30,000,735.27	6,443,741.73
Presenting launch Louise to French Government, act of Aug. 25, 1914.....	6,000.00	.....	.....	.....	6,000.00	.....	.....	.....	159.01
Private act Feb. 18, 1913, Oscar F. Lackey.....	1,500.00	.....	.....	.....	1,500.00	.....	5,840.99	5,840.99	1,500.00
Annual payment to Republic of Panama.....	\$250,000.00	.....	.....	.....	250,000.00	250,000.00	.....	250,000.00	.....
Judgment, Court of Claims, war.....	1,000.00	.....	.....	.....	1,000.00	1,000.00	.....	1,000.00	.....
Total.....	7,500.00	251,000.00	.....	.....	258,500.00	251,000.00	5,840.99	256,840.99	1,659.01
Panama fortifications.....	1,743,354.09	.....	265.00	.....	1,743,619.09	853,298.32	371,748.98	1,230,047.30	513,571.79
Armament of fortifications.....	640,740.45	.....	.....	.....	640,740.45	483,979.86	.....	483,979.86	156,760.59
Army quarters, storehouses, etc.....	1,290,000.00	.....	.....	.....	1,290,000.00	271,176.00	969,381.91	1,240,557.91	49,442.09
Electric light and power plants.....	3,081.00	.....	.....	.....	3,081.00	1,023.30	.....	1,023.30	2,057.70
Fire control at fortifications.....	283,230.70	.....	.....	.....	283,230.70	41,998.34	134,304.21	176,302.55	106,928.15
Maintenance of clearings and trails.....	45,000.00	.....	39.47	.....	45,039.47	39,246.64	3,030.04	42,276.68	2,762.79
Maintenance of searchlight and electric power equipment.....	7,500.00	.....	.....	2,293.66	9,793.66	8,142.01	.....	8,142.01	1,591.65
Preservation and repair of fortifications.....	15,000.00	.....	.....	5,542.81	20,542.81	11,476.74	.....	11,476.74	9,066.07
Reserve equipment for fortifications.....	50,000.00	.....	.....	.....	50,000.00	8,000.00	.....	8,000.00	42,000.00
Searchlights for seacoast fortifications.....	79,686.00	.....	.....	.....	79,686.00	13,662.35	.....	13,662.35	66,003.65
Submarine mines.....	2,261.61	.....	.....	.....	2,261.61	2,261.61	.....	2,261.61	.....
Total.....	4,159,833.85	.....	304.47	7,776.47	4,167,914.79	1,739,265.17	1,478,465.14	3,217,730.31	950,184.48
Grand total.....	26,767,352.80	251,000.00	7,220,622.65	6,631,916.34	40,870,891.79	26,843,390.23	6,631,916.34	33,475,306.57	7,395,585.22

TABLE NO. 34.—*Payments made by fiscal officers, fiscal year 1916.*  
PAYMASTER.

Month.	Panama Canal payments.				Panama Railroad payments.			Grand total.
	Gold rolls.	Silver rolls.	Vouchers.	Total.	Pay rolls.	Vouchers.	Total.	
1915.								
July.....	\$491,786.35	\$540,667.95	\$331,058.37	\$1,363,512.67	\$232,421.80	\$580,041.59	\$812,463.39	\$2,175,976.06
August.....	522,970.73	522,694.70	581,975.40	1,627,640.83	252,077.45	298,305.20	550,382.71	2,178,023.54
September.....	498,730.68	518,676.89	781,574.54	1,798,982.11	222,599.80	317,460.25	540,060.05	2,339,042.16
October.....	477,108.02	402,131.71	477,348.11	1,446,587.84	202,071.69	699,002.96	901,074.65	2,347,662.49
November.....	502,457.43	488,464.64	452,061.41	1,442,983.48	259,567.20	363,238.00	622,805.20	2,057,788.68
December.....	496,442.89	457,763.10	517,441.04	1,471,647.03	261,490.07	493,251.24	754,741.31	2,226,388.34
1916.								
January.....	489,865.34	459,862.71	587,765.56	1,537,493.61	220,282.44	272,703.38	492,985.82	2,030,479.43
February.....	502,696.32	454,310.65	577,202.97	1,534,209.94	245,826.95	421,398.08	667,225.03	2,201,434.97
March.....	470,500.83	473,935.69	516,269.00	1,460,705.52	234,050.38	352,561.35	586,611.73	2,056,317.25
April.....	512,500.36	516,037.72	539,625.28	1,568,163.36	258,360.40	519,378.49	777,738.89	2,375,902.25
May.....	477,727.70	447,855.36	531,533.42	1,457,116.48	244,093.05	923,017.82	1,167,110.87	2,624,227.35
June.....	501,837.45	449,351.97	540,185.94	1,491,375.36	254,535.35	566,375.12	820,910.47	2,312,285.83
Total.....	5,983,624.10	5,821,753.09	6,434,041.04	18,239,418.23	2,887,376.58	5,806,733.54	8,694,110.12	26,933,528.35
COLLECTOR.								
Month.	Disbursing clerk.		Total.	Canal Zone revenues.	Clubhouse funds.	Trust funds.	Postal savings funds.	Money-order funds.
	July.	August.	September.	October.	November.	December.	January.	February.
1915.								
July.....	\$610,925.78	\$892,377.14	\$737,872.85	\$1,207,924.42	\$223,086.80	\$1,416.44	\$6,078.70	\$1,341.66
August.....	757,872.92	1,207,924.42	1,013,618.86	200,255.22	271,486.72	23,085.51	6,312.83	2,598.14
September.....	1,013,618.86	200,255.22	237,223.62	17,080.43	234,028.01	332.13	7,295.55	196.23
October.....	588,014.66	889,864.05	794,322.41	203,922.67	203,890.08	278.90	7,083.52	806.66
November.....	889,864.05	794,322.41	203,922.67	211,019.17	4.13	7,504.61	505.18	446.15
December.....	794,322.41	203,922.67	211,019.17	3.00	17,294.50	111.67	1,320.93	778.52
January.....	203,922.67	211,019.17	3.00	12,117.40	13,647.43	474.33	526.37	170,169.00
February.....	12,117.40	13,647.43	474.33	526.37	13,647.43	474.33	526.37	170,169.00
March.....	13,647.43	474.33	526.37	170,169.00	13,647.43	474.33	526.37	170,169.00
April.....	170,169.00	174,919.04	170,169.00	174,919.04	170,169.00	174,919.04	170,169.00	174,919.04
May.....	174,919.04	170,169.00	174,919.04	170,169.00	174,919.04	170,169.00	174,919.04	170,169.00
June.....	170,169.00	174,919.04	170,169.00	174,919.04	170,169.00	174,919.04	170,169.00	174,919.04
Total.....	10,174,594.02	2,566,452.86	57,813.11	127,981.39	9,238.53	5,650.00	2,365,799.83	2,365,799.83

TABLE No. 35.—Statement of collections repaid to appropriations and to individuals and companies and collections deposited to miscellaneous receipts during the fiscal year ending June 30, 1916.

Department and classification.	Total, fiscal year 1916.	Department and classification.	Total, fiscal year 1916.
<b>DEPARTMENT OF OPERATION AND MAINTENANCE.</b>		<b>ACCOUNTING DEPARTMENT.</b>	
Construction and repairs.....	\$741,498.07	Lost metal checks.....	\$1,812.75
Shopwork.....	1,562,876.64	Cablegrams.....	2,269.89
Electric work.....	220,060.72	Proportion of salaries.....	136,599.35
Electric current.....	79,948.52	Lost property.....	978.97
Compressed air.....	2,147.36	Overpayments, refunds, etc.....	49,324.92
Train service and use of rolling equipment.....	38,636.65	Services of employees obtaining bill of health for vessels.....	174.00
Tug service.....	54,614.03	Total, accounting department.....	191,159.88
Service of other floating equipment.....	26,150.90	<b>EXECUTIVE DEPARTMENT.</b>	
Pilotage.....	46,442.50	Proportion of salaries.....	86,521.90
Wharfage.....	29,700.27	Photographs and prints.....	1,043.83
Sales of water.....	86,088.71	Motor-car service.....	4,270.46
Water rentals, Panama and Colon.....	147,500.00	Minor services, supplies, and property.....	361.20
Unserviceable material, supplies and property.....	20,247.91	Total, executive department.....	92,197.39
Meals on floating equipment.....	51,588.12	Total.....	6,681,591.83
Rental of mooring buoys.....	48.00	<b>CIVIL GOVERNMENT.</b>	
Handling lines.....	14,130.63	School tuition.....	2,561.32
Steamship inspection.....	4,033.25	Sale of school books.....	399.95
Dredging.....	21,868.52	Police service.....	27,242.86
Hoisting.....	76,775.67	Minor services, supplies, and property.....	1,482.73
Minor supplies, services, and property.....	6,141.79	Gamboa prison mess.....	23.00
Proportion of construction and operation of quarters.....	14,785.41	Sales of lumber, industrial training school.....	45.67
Lost property.....	49.04	Sales of ammunition for target practice.....	321.33
Pay-roll errors.....	6.52	Total civil government.....	32,076.86
Total, department of operation and maintenance.....	3,245,339.23	<b>MISCELLANEOUS.</b>	
<b>SUPPLY DEPARTMENT.</b>		Land rental.....	5,592.40
Subsistence:		Building rental.....	1,927.39
Hotel Tivoli.....	163,008.94	Land office expenses.....	12,000.00
Hotel Aspinwall.....	23,611.35	Joint Land Commission transcripts.....	192.20
Line hotels.....	8,705.33	Rental of equipment.....	8,152.33
Messes.....	784.00	Republic of Panama election expenses, 1912.....	16,946.32
Minor supplies, services, and property.....	816.82	Tile roofing manufactured on Isthmus for Dock No. 6.....	30,727.11
Hotel coupon books.....	268.80	Sale of roofing recovered from Tax Building, Mount Hope.....	55.00
Laborers' meal tickets.....	133,571.18	Proportion of amount paid injured employees.....	21.60
Commissary coupon books honored by Panama Canal.....	537,900.97	Leave earned by superintendent of schools prior to July 1, 1915.....	743.33
Lost property.....	44.62	Sale of old Panama Railroad buildings.....	60.00
Total, subsistence.....	868,712.06	Total miscellaneous.....	76,417.68
<b>Quartermaster:</b>		<b>HEALTH DEPARTMENT.</b>	
Material from stock.....	1,627,780.66	Ancon Hospital:	
Rock, sand, gravel, and screenings.....	63,337.61	Fees.....	223,945.28
Printing and binding.....	18,161.89	Mess.....	9,685.39
Corral.....	80,716.12	Burials.....	2,708.79
Miscellaneous jobs.....	126,702.35	Miscellaneous.....	462.61
Rental of gold quarters.....	4,857.28	Colon Hospital:	
Rental of silver quarters.....	65,536.55	Fees.....	10,988.27
Garage rental.....	1,582.91	Mess.....	912.17
Ancon nursery.....	403.13	Miscellaneous.....	327.63
Handling of fuel oil.....	24,846.28	Palo Seco Leper Asylum.....	14,713.25
Operation of stores.....	40,500.00	Line dispensaries.....	1,089.90
Operation of quarters.....	48,000.00	Quarantine:	
Janitor service.....	388.60	Subsistence.....	16,749.39
Minor services, supplies, and property.....	2,417.04	Other charges.....	4,619.04
Cost of making sales.....	170,898.79		
Building rental.....	210.50		
Containers.....	7,654.55		
Rental of equipment.....	189.01		
Total, quartermaster.....	2,284,183.27		
Total, supply department.....	3,152,895.33		

TABLE NO. 35.—*Statement of collections repaid to appropriations and to individuals and companies and collections deposited to miscellaneous receipts during the fiscal year ending June 30, 1916—Continued.*

Department and classification.	Total, fiscal year 1916.	Department and classification.	Total, fiscal year 1916.
HEALTH DEPARTMENT—continued.		HEALTH DEPARTMENT—continued.	
Sanitation:		Sales from medical store.....	\$4,069.46
Panama.....	\$7,711.81	Unserviceable material, supplies, and equipment.....	732.13
Colon.....	11,609.72	Minor services, supplies, and property.....	197.10
Canal Zone.....	5,487.38	Expense incurred in deporting insane patients.....	376.06
Street cleaning:		Total health department.....	430,536.28
Panama.....	50,666.62	Total repay to appropriations..	7,220,622.65
Colon.....	20,008.73		
Corozal Hospital:			
Produce.....	7,428.89		
Pasturage.....	96.70		
Burials.....	387.00		
Insane asylum.....	35,562.96		

## RECAPITULATION.

Department of operation and maintenance.....	\$3,245,339.23	Miscellaneous receipts, United States funds:	
Supply department:		Tolls.....	\$2,395,928.77
Subsistence.....	868,712.06	Sale of construction material and equipment.....	122,622.92
Quartermaster.....	2,284,183.27	Water rental, Panama and Colon.....	91,376.89
Accounting department.....	191,159.88	Licenses and taxes.....	14,194.06
Executive department.....	92,197.39	Court fees and fines.....	17,417.44
Total construction and engineering.....	6,681,591.83	Postal receipts.....	96,907.36
Total civil government.....	32,076.86	Miscellaneous, Canal Zone.....	645.82
Total health department.....	430,536.28	Police fines.....	137.00
Total miscellaneous.....	76,417.68	Interest, bank balances.....	17,387.34
Total repayment to appropriations.....	7,220,622.65	Forfeitures.....	28.00
Collections for individuals and companies:		Sale of old French scrap.....	102.60
Panama Railroad Company—General.....	15,089.61	Pay-car overages.....	11.16
Panama Railroad Company—Commissary books.....	2,879,280.83	Overages, collecting agents.....	5.47
Federal income tax.....	442.60	Total miscellaneous receipts..	2,756,764.83
Other individuals and companies.....	4,383.62	Grand total for year.....	12,876,584.14
Total collections for individuals and companies.....	2,899,196.66		

TABLE NO. 36.—*Statement of transactions in the collector's special deposit account during the fiscal year ending June 30, 1916.*

## IN THE UNITED STATES.

Month.	Deposits.	Panama Canal bills applied.	Payments to individuals and companies. <sup>1</sup>	Refunds.
1915.				
July.....	\$339,579.10	\$248,484.04	\$58,731.80	\$46,579.05
August.....	401,831.01	248,746.45	61,170.42	58,426.69
September.....	461,109.37	167,550.11	96,486.29	38,326.15
October.....	148,199.47		194,877.38	129,335.74
November.....	37,005.00	20,932.44	114,692.26	23,827.37
December.....	45,500.00	3,000.27	21,558.50	15,276.90
1916.				
January.....	17,000.00	4,586.88	11,337.46	175.99
February.....	39,500.00	3,120.29	16,128.87	26,072.62
March.....	1,750.00	5.00	5.67	10,001.02
April.....	165,514.20	83,236.61	36,051.33	23.47
May.....	214,503.80	138,160.73	51,565.38	49,881.01
June.....	245,263.19	120,708.33	54,842.61	18,212.96
Total.....	2,146,755.14	1,038,531.15	717,447.97	416,138.97

<sup>1</sup> Includes the Panama Railroad Company, Central and South American Telegraph Co., and other individuals and companies.



TABLE No. 36.—Statement of transactions in the collector's special deposit account during the fiscal year ending June 30, 1916—Continued.

## ON THE ISTHMUS.

Month.	Deposits.	Panama canal bills applied.	Payments to individuals and companies.	Refunds.
1915.				
July.....	\$506,544.92	\$335,547.45	\$60,198.47	\$14,280.20
August.....	252,596.01	268,668.86	71,145.73	4,639.16
September.....	406,377.68	198,117.16	91,499.97	2,095.80
October.....	107,676.67	19,637.13	114,010.11	33,452.82
November.....	109,071.78	34,264.31	150,853.15	9,361.32
December.....	33,504.76	16,093.80	22,482.29	103.26
1916.				
January.....	112,256.07	10,987.98	40,570.69	2,186.07
February.....	241,244.49	45,504.37	162,112.76	33,803.83
March.....	303,132.69	60,178.44	282,766.78	4,093.56
April.....	488,072.05	197,953.85	211,112.79	8,432.12
May.....	382,533.25	257,139.95	123,310.98	6,115.70
June.....	443,108.15	271,339.17	158,319.56	6,312.14
Total.....	3,386,117.92	1,715,432.47	1,488,383.28	124,875.98

## RECAPITULATION.

	In the United States.		On the Isthmus.	
	Debit.	Credit.	Debit.	Credit.
On hand July 1, 1915.....	\$131,428.54	.....	\$101,639.42	.....
Deposits during year.....	2,146,755.14	.....	3,386,117.92	.....
Panama Canal bills applied.....	.....	\$1,038,531.15	.....	\$1,715,432.47
Payments to individuals and companies.....	.....	717,447.97	.....	1,488,383.28
Refunds.....	.....	416,138.97	.....	124,875.98
On hand June 30, 1916.....	.....	106,065.59	.....	159,065.61
Total.....	2,278,183.68	2,278,183.68	3,487,757.34	3,487,757.34

TABLE No. 37.—Statement of audited pay rolls on Isthmus during fiscal year 1916.

Operation and maintenance.....		\$8,072,412.17
Executive office.....		\$325,972.73
Executive.....	\$16,401.68	
Record.....	54,100.75	
Personnel.....	22,427.73	
General.....	37,145.61	
Correspondence.....	58,268.53	
Property.....	27,320.42	
Timekeeping.....	90,653.86	
Clubs and playgrounds.....	17,554.15	
Canal Record.....	2,100.00	
Engineer of maintenance.....		599,474.69
Lock operation and maintenance.....	451,288.09	
Office engineer.....	67,440.57	
Surveys.....	36,047.24	
Meteorology and hydrography.....	21,567.20	
Maintenance, Gatun dam and back fill.....	23,131.59	
Marine division.....		211,297.72
Office.....	4,033.33	
Port captain, Balboa.....	90,849.16	
Port captain, Cristobal.....	97,377.21	
Maintenance, aids to navigation.....	19,038.02	
Electrical.....		447,363.31
Municipal engineering.....		878,241.10
Dredging.....		1,754,944.03
Mechanical.....		2,215,976.12
Balboa shops.....	1,380,640.85	
Paraiso shops.....	377,106.71	
Cristobal shops.....	458,228.56	
Railroad transportation.....		270,619.56
Supply department.....		948,230.74
Quartermaster.....	828,843.33	
Office.....	\$26,089.67	
Storehouses.....	235,601.15	
District quartermasters.....	505,236.35	
Printing plant.....	46,943.86	
Oil handling plant.....	14,972.30	
Subsistence.....		119,387.41

## Operation and maintenance—Continued.

Accounting.....	\$378,422.44	
Auditor.....	\$304,309.93	
Paymaster.....	41,286.78	
Collector.....	32,825.73	
Injury and death.....	41,869.73	
Construction and equipment.....		\$2,063,325.92
Terminals.....	1,178,908.34	
Building.....	800,706.41	
Joint Land Commission.....	137,522.26	
Land office and special attorney.....	21,949.80	
Lighthouse erection.....	2,572.91	
Injury and death.....	21,666.20	
Civil government.....		411,358.22
Civil affairs.....	25,385.84	
Posts.....	74,719.27	
Police.....	164,562.84	
Fire.....	56,232.11	
District attorney.....	7,099.19	
District court.....	15,406.66	
Magistrate courts.....	9,198.34	
Marshall.....	7,137.53	
Schools.....	51,557.31	
Injury and death.....	59.13	
Sanitation.....		523,698.39
Chief health office.....	3,126.92	
Medical storehouse.....	9,665.46	
Ancon Hospital.....	187,459.10	
Colon Hospital.....	21,437.25	
Santo Tomas Hospital.....	9,438.02	
Palo Seco leper asylum.....	8,890.07	
Dispensaries.....	26,718.08	
Quarantine.....	34,906.44	
Office.....	1,620.67	
Balboa.....	12,929.16	
Cristobal.....	19,156.61	
Bocas del Toro.....	1,200.00	
Corozal Hospital.....	35,307.98	
Asylum.....	22,513.67	
Farm.....	12,794.31	
Health office, Panama.....	71,363.13	
Health office, Colon.....	50,600.10	
Zone sanitation.....	64,592.74	
Injury and death.....	193.10	
Fortifications.....		580,721.48
Construction.....	287,303.80	
Army quarters, storehouses, etc.....	268,035.20	
Ordnance machinists.....	18,889.75	
Fire control.....	5,127.60	
Injury and death.....	1,365.13	
Leave accrued prior to July 1, 1915, paid from Panama Canal fund.....		97,268.70
Operation and maintenance.....	83,577.25	
Sanitation.....	6,275.88	
Civil government.....	7,415.57	
Omitted time prior to Apr. 1, 1914.....		1,763.74
Total.....		11,750,548.62

<sup>1</sup> Includes \$27,973.56 paid by voucher.

TABLE No. 38.—Statement of accounts receivable registered during the fiscal year ending June 30, 1916.

Month.	Num-ber of bills regis-tered.	Total.	Against the Panama R. R.	Against the Canal Zone Govern-ment.	Against the Republic of Panama.	Against other de-partments of United States Gov-ernment.	Against steamship companies.	Against other indi-viduals and companies.	Trust funds.		For various collec-tions; hos-pitals and messes.	Tolls.	Repay to appro-priation.
									For pay-roll deductions.	Other collections.			
1915.													
July.....	1,050	\$1,300,471.41	\$242,715.92	\$53.32	\$11,498.29	\$90,474.38	\$22,250.81	\$125,285.84	\$214,278.17	\$16,732.50	\$3,816.51	\$573,365.67	\$487,978.52
August.....	1,063	1,457,520.96	503,527.44	841.59	15,292.12	36,981.75	39,698.55	134,929.71	208,739.40	17,398.13	4,010.24	496,792.03	671,386.58
September...	1,084	1,071,107.09	283,131.68	.....	9,689.18	38,715.05	28,704.74	120,930.22	215,136.86	20,578.32	4,723.34	349,498.30	479,885.48
October.....	1,278	706,211.78	285,577.79	.....	21,917.22	39,702.01	41,987.19	76,431.66	210,770.96	16,359.26	3,445.69	.....	456,147.23
November...	964	657,292.20	307,275.77	16,946.32	10,327.79	38,394.66	22,190.61	42,893.52	209,034.08	6,561.05	3,608.40	.....	436,597.75
December...	847	683,310.33	275,320.82	3,343.33	10,525.53	41,808.47	14,118.89	96,026.62	207,984.28	17,823.30	5,533.09	10,826.00	418,745.84
1916.													
January.....	888	826,197.55	333,180.90	5.76	25,884.40	71,301.60	16,619.07	119,543.12	243,230.04	12,180.09	3,598.18	654.39	537,723.58
February....	888	684,704.07	312,525.67	.....	8,682.61	41,635.40	27,201.25	71,021.29	201,701.40	17,035.45	4,007.00	831.00	449,965.71
March.....	1,016	710,313.83	316,520.66	.....	12,558.90	55,925.89	27,403.86	60,385.21	210,280.87	21,642.50	5,177.14	418.80	473,989.32
April.....	1,158	1,090,463.49	419,585.34	.....	24,649.86	40,534.05	35,135.65	67,754.24	220,292.70	12,995.21	3,857.34	235,618.44	572,513.41
May.....	1,310	1,187,980.48	425,701.55	.....	11,041.49	47,518.18	28,307.10	78,973.19	210,518.87	13,619.53	4,276.78	368,023.79	577,209.13
June.....	1,208	1,446,614.12	467,372.25	.....	18,823.55	64,802.69	25,008.64	61,330.82	423,507.21	12,497.05	3,472.91	363,799.00	624,520.57
Total.....	12,754	11,786,187.91	4,182,435.79	21,190.32	180,800.94	607,794.73	328,026.36	1,055,525.44	2,775,534.90	185,302.39	49,686.62	2,399,830.42	6,186,622.08

TABLE No. 39.—Statement of commissary and hotel coupon books issued during fiscal year ending June 30, 1916, for which collections have been made on pay rolls.

	Commissary books.						Hotel books.					
	\$2.50 books.			\$5 books.			\$15 books.			\$4.80 books.		
	Number.	Value.		Number.	Value.	Total value.	Number.	Value.		Number.	Value.	Total value.
1915-16.												
July.....	24,350	\$60,875.00		27,089	\$135,445.00	\$262,710.00	4,426	\$66,390.00				\$262,710.00
August.....	24,894	62,255.00		26,910	134,550.00	263,205.00	4,428	66,420.00				263,205.00
September.....	23,514	58,785.00		26,164	130,820.00	257,030.00	4,495	67,425.00				257,030.00
October.....	24,284	60,710.00		26,434	132,170.00	263,875.00	4,733	70,995.00				263,875.00
November.....	24,894	62,255.00		26,564	132,820.00	268,450.00	4,893	73,395.00				268,450.00
December.....	22,946	57,365.00		32,491	162,455.00	307,630.00	5,854	87,810.00				307,630.00
January.....	22,716	56,790.00		26,058	130,200.00	239,500.00	4,828	72,425.00				239,500.00
February.....	26,008	65,020.00		26,832	134,160.00	269,605.00	4,695	70,425.00				269,605.00
March.....	26,592	66,330.00		28,133	140,665.00	279,730.00	4,819	72,735.00				279,730.00
April.....	23,325	63,312.50		27,218	136,090.00	271,252.50	4,790	71,850.00				271,252.50
May.....	24,343	61,357.50		27,218	136,090.00	269,777.50	4,822	72,330.00				269,777.50
June.....	25,859	64,647.50		28,225	141,125.00	277,367.50	4,773	71,595.00				277,367.50
Total.....	295,865	739,662.50		329,336	1,646,680.00	3,250,132.50	57,586	863,790.00				3,250,132.50

TABLE No. 40.—Statement of commissary and hotel coupon books sold for cash during fiscal year ending June 30, 1916.

[illegible]

TABLE No. 41.—Statement of meal tickets issued to employees during fiscal year ending June 30, 1916, for which collections have been made on pay rolls.

	5-cent.		9-cent.		13-cent.		27-cent.		40-cent.		Total value.
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	
July.....	3,488	\$174.40	6,904	\$621.36	492	\$65.60	12,993	\$3,508.11	19,820	\$7,928.00	\$12,297.47
August.....	2,521	126.05	5,820	523.80	287	38.27	11,408	3,080.16	17,062	6,821.80	10,583.08
September.....	1,404	70.20	4,574	411.66			11,242	3,033.34	13,846	9,055.60	10,555.60
October.....	6,500	325.00	5,406	486.54			13,115	3,541.05	17,889	7,155.00	11,508.19
November.....	7,402	370.10	3,901	351.09			10,461	2,824.47	18,376	7,350.40	10,896.06
December.....	2,658	132.90	3,816	343.44			7,070	1,908.90	14,318	5,727.20	8,112.44
January.....	4,584	229.20	5,695	512.55			9,294	2,509.38	19,623	7,819.20	11,100.33
February.....	5,401	270.05	4,653	418.77			7,916	2,137.32	17,173	6,869.20	9,695.34
March.....	5,066	298.30	4,780	430.20			8,488	2,231.76	18,508	7,403.20	10,423.46
April.....	4,185	209.25	6,090	548.10			7,355	1,985.85	18,829	7,531.60	10,274.80
May.....	4,643	32.15	9,220	829.80			7,607	2,033.89	15,293	7,901.20	10,517.04
June.....	668	33.40	11,743	1,056.87	64	8.53	8,818	2,380.86	21,111	8,444.40	11,924.06
Total.....	45,420	2,271.00	72,602	6,534.18	843	112.40	115,767	31,237.09	215,558	\$6,223.20	126,397.87

TABLE 42.—*Receipts Canal Zone funds, from May 1, 1904, to June 30, 1916.*

On account of—	May 1, 1904, to June 30, 1915.	July 1, 1915, to June 30, 1916.	Total.
<b>Revenues:</b>			
Motor vehicle and conveyance licenses.....	\$26,922.42		\$26,922.42
Insurance and corporation tax.....	6,546.39		6,546.39
Merchandise and peddling licenses.....	625,331.47		625,331.47
Public entertainment licenses.....	7,673.27		7,673.27
Slaughter tax.....	94,034.01		94,034.01
Real estate tax.....	160,630.97	<sup>1</sup> \$28.38	160,602.59
Court fees and fines.....	279,628.07	<sup>1</sup> 288.25	279,339.82
Market land and building rental.....	172,762.34		172,762.34
Water tax.....	140,883.51	53.29	140,936.80
Steamship inspection.....	11,161.89	15.00	11,176.89
School tuition.....	6,329.78		6,329.78
Interest.....	228,216.54	5,868.58	234,085.12
Miscellaneous.....	79,899.44	<sup>1</sup> 24.51	79,874.93
<b>Total revenues.....</b>	<b>1,840,020.10</b>	<b>5,595.73</b>	<b>1,845,615.83</b>
<b>Municipal funds transferred.....</b>	<b>83,660.36</b>		<b>83,660.36</b>
<b>Postal receipts:</b>			
Postage stamps.....	763,489.18	25.00	763,505.18
Stamp books.....	1,480.02		1,480.02
Sale of mail matter.....	52.20		52.20
Handling Panama Railroad Company's mail.....	3,750.00	500.00	4,250.00
Box rents.....	2,973.65		2,973.65
Money-order fees.....	176,171.73		176,171.73
Money-order exchange and overage.....	164.46	103.54	268.00
<b>Total postal receipts.....</b>	<b>948,072.24</b>	<b>628.54</b>	<b>948,700.78</b>
<b>Summary of receipts:</b>			
Revenue.....	1,840,020.10	5,595.73	1,845,615.83
Municipal funds.....	83,660.36		83,660.36
Postal receipts.....	948,072.24	628.54	948,700.78
<b>Total receipts.....</b>	<b>2,871,752.70</b>	<b>6,224.27</b>	<b>2,877,976.97</b>

<sup>1</sup> Debits due to refunds.

NOTE.—Postal receipts from July 1, 1916, to June 30, 1916, cover money due on July 1, 1915.

TABLE 43.—*Expenditures from July 1, 1915, to June 30, 1916.*

On account of—	July 1, 1905, to June 30, 1915.	July 1, 1915, to June 30, 1916.	Total.
<b>Roads and trails:</b>			
Construction.....	\$484,982.80	\$590.11	\$485,572.91
Maintenance.....	159,219.76	2,418.06	161,637.82
<b>Waterworks and sewers:</b>			
Construction.....	51,965.20		51,965.20
Maintenance.....	13,504.02		13,504.02
<b>Market and slaughterhouses:</b>			
Construction.....	20,661.09		20,661.09
Maintenance.....	33,646.02	9.14	33,655.16
Street lighting.....	9,192.65		9,192.65
Miscellaneous public works.....	62,961.39	2.00	62,963.39
Impounded animals.....	109.90	5.60	115.50
Sanitation, native villages.....	89,924.15		89,924.15
Incidentals.....	15.00		15.00
	<b>926,181.98</b>	<b>3,024.91</b>	<b>929,206.89</b>
<b>Public schools:</b>			
Salaries, superintendent, teachers, and clerks.....	471,866.26	753.83	472,620.09
Stationery and supplies.....	37,471.93	661.96	38,133.89
Corral service.....	1,457.90	34.23	1,492.13
Janitor service.....	22,066.47	358.93	22,425.40
Railroad transportation.....	2,782.00	362.00	3,144.00
Furniture and equipment.....	18,341.14	60.26	18,401.40
Construction, buildings.....	134,051.84	2,881.68	136,933.52
Maintenance, building.....	28,126.54	59.82	28,186.36
Traveling and miscellaneous.....	41,961.76	433.06	42,394.82
<b>Total, public schools.....</b>	<b>758,125.84</b>	<b>5,605.77</b>	<b>763,731.61</b>

TABLE 43.—*Expenditures from July 1, 1915, to June 30, 1916—Continued.*

On account of—	July 1, 1905, to June 30, 1915.	July 1, 1915, to June 30, 1916.	Total.
<b>Miscellaneous:</b>			
Salaries—			
Tax collectors.....	\$25,886.14	.....	\$26,886.14
District judges.....	87,750.15	.....	87,750.15
Magistrates.....	11,541.68	\$1,159.17	12,700.85
Supplies and miscellaneous.....	11,026.14	123.13	11,149.27
Equipment.....	453.53	.....	453.53
Maintenance of charity patients.....	18,176.90	200.00	18,376.90
Municipal prisoners (rations).....	74,796.41	495.63	75,292.04
<b>Total miscellaneous.....</b>	<b>230,630.95</b>	<b>1,977.93</b>	<b>232,608.88</b>
<b>Contingent expenses:</b>			
Gratuity, discharged penitentiary prisoners.....	5,222.50	17.50	5,215.00
Election expenses.....	9,679.49	16,946.32	26,625.81
Incidentals.....	7,798.88	252.82	8,051.70
<b>Total contingent expenses.....</b>	<b>22,700.87</b>	<b>17,191.64</b>	<b>39,892.51</b>
<b>Postal service:</b>			
Purchase of stamps.....	300,229.17	22,070.12	322,299.29
Transportation of mails—			
Isthmus.....	74,256.84	.....	74,256.84
Ocean.....	178,628.16	6,556.74	185,184.90
Stationery, office and miscellaneous supplies.....	58,786.73	548.24	59,334.97
Corral service.....	5,038.82	339.94	5,378.76
Repairs to furniture and fixtures.....	85.26	.....	85.26
New equipment.....	1,362.52	59.92	1,422.44
Incidentals.....	1,880.18	119.40	1,999.58
Transfer to Panama Canal as reimbursement in part for salaries paid.....	253,513.21	.....	253,513.21
<b>Total postal service.....</b>	<b>873,780.89</b>	<b>29,694.36</b>	<b>903,475.25</b>
<b>Summary of disbursements:</b>			
Zone public works.....	926,181.98	3,024.91	929,206.89
Public schools.....	758,125.84	5,605.77	763,731.61
Miscellaneous.....	230,630.95	1,977.93	232,608.88
Contingent expenses.....	22,700.87	17,191.64	39,892.51
Postal service.....	873,780.89	29,694.36	903,475.25
<b>Total disbursements.....</b>	<b>2,811,420.53</b>	<b>57,494.61</b>	<b>2,868,915.14</b>

1 Credit.

NOTE.—Postal-service expenditures from July 1, 1915, to June 30, 1916, cover expenses incurred previous to July 1, 1915.

TABLE 44.—*Statement of balances Canal Zone funds, with collector, by appropriations, June 30, 1916.*

Public improvements and schools.....	\$2,428.73
Miscellaneous and contingent.....	3,861.50
Postal receipts, 1915.....	2,771.60
Money-order funds.....	440,553.91
Clubhouse funds.....	4,625.21
Trust funds.....	10,191.81
Postal-savings funds.....	14,001.00
<b>Total.....</b>	<b>478,433.76</b>

TABLE 45.—*Statement of receipts and disbursements Canal Zone funds, May 1, 1904, to June 30, 1916.*

<b>Receipts:</b>		
Revenues collected.....	\$1, 929, 276. 19	
Postal receipts.....	948, 700. 78	
Total collections.....		\$2, 877, 976. 97
<b>Disbursements:</b>		
Zone public works.....	929, 206. 89	
Public schools.....	763, 731. 61	
Miscellaneous.....	232, 608. 88	
Contingent expenses.....	39, 892. 51	
Postal services.....	903, 475. 25	
Total disbursements.....		2, 868, 915. 14
Available for expenditure.....		9, 061. 83
<b>Collector's balance June 30, 1916:</b>		
Public improvements and schools.....	2, 428. 73	
Miscellaneous and contingent.....	3, 861. 50	
Postal receipts, 1915.....	2, 771. 60	
		9, 061. 83
<b>Separate statement covering postal services:</b>		
<b>Receipts—</b>		
Stamp sales.....	763, 505. 18	
Stamp book sales.....	1, 480. 02	
Sale of mail matter.....	52. 20	
Handling Panama Railroad Company's mail..	4, 250. 00	
Box rents.....	2, 973. 65	
Money-order fees.....	176, 171. 73	
Money-order exchange and overages.....	268. 00	
		948, 700. 78
<b>Disbursements—</b>		
Balance of funds prior to Mar. 4, 1907.....	42, 453. 93	
Consolidated with regular Zone revenues.....		
Purchase of stamps.....	322, 299. 29	
Miscellaneous expenditures.....	327, 662. 75	
Transfer to Panama Canal as reimbursement in part for salaries paid.....	253, 513. 21	
		945, 929. 18
Available for expenditure.....		2, 771. 60
Collector's balance.....		2, 771. 60



TABLE NO. 46.—*Postal Service—Statement showing total value of money orders issued, money orders paid, money orders outstanding, and balance of money-order funds, June 30, 1916.*

Year ending June 30—	Money orders issued.	Money orders paid.				Total.
		United States.	Canal Zone.	Martinique.	Costa Rica.	
1907.....	\$2,369,031.49	\$1,531,251.91	\$208,165.48	.....	.....	\$1,789,417.39
1908.....	4,686,684.98	2,875,719.61	1,017,750.97	.....	.....	3,893,470.58
1909.....	5,166,719.46	3,583,419.57	1,492,144.76	.....	.....	5,075,564.33
1910.....	5,228,553.60	4,008,650.16	1,331,568.20	.....	.....	5,402,485.96
1911.....	5,304,906.60	3,725,996.12	1,337,915.09	\$2,267.60	.....	5,069,983.29
1912.....	4,915,077.26	3,521,511.95	1,280,397.83	6,022.08	.....	4,811,149.18
1913.....	4,883,624.13	4,286,948.31	881,728.73	8,176.95	\$1,062.40	5,181,369.79
1914.....	4,029,364.97	4,070,694.55	776,265.68	11,684.18	4,634.53	4,963,278.94
1915.....	2,873,182.84	2,699,533.06	431,004.25	6,183.64	1,250.55	3,137,971.50
1916.....	2,417,033.83	2,102,740.27	289,011.70	5,979.45	1,172.02	2,398,903.44
Sub total.....	41,874,209.16	.....	9,045,952.74	.....	.....	41,623,544.40
Deposit orders:						
1915.....	1,075,570.00	.....	722,680.00	.....	.....	722,680.00
1916.....	1,101,190.00	.....	1,103,430.00	.....	.....	1,103,430.00
Totals.....	44,050,969.16	32,516,465.51	10,872,062.74	49,960.55	11,165.60	43,449,654.40

## SUMMARY.

Total money orders issued.....	\$44,050,969.16
Total money orders paid.....	43,449,654.40

Unpaid money orders outstanding.....	\$801,314.76
<i>Money-order funds:</i>	
Cash in hands of collector, Panama Canal.....	439,753.91
Due from United States Postal Department.....	143,261.93
Due from Martinique Postal Department.....	1,833.55
Due from Costa Rica Postal Department.....	271.00
Cash in hand of postmasters, money-order account.....	\$16,211.30
Cash in hands of postmasters, money-order fees.....	36.93
	16,174.37

NOTE.—The Martinique and Costa Rica lists of paid Canal Zone orders for June, 1916, not included. Martinique list for June, 1915, included; United States lists of paid Canal Zone orders for April, May, and June, 1916, subject to adjustments for duplicate payments, to be determined on complete audit of United States lists.

TABLE No. 47.—*Postal service—Statement showing the monthly money-order business of the Canal Zone postal service during the fiscal year ended June 30, 1916.*

Month.	Issued.	Fees.	Money orders paid by Canal Zone post offices.				Canal Zone orders paid by—			Cash remittances to United States Postoffice Department.
			United States.	Martinique.	Costa Rica.	Canal Zone.	Martinique.	Costa Rica.	United States.	
1915.										
July.....	\$323,538.58	\$1,100.48	\$12,813.85	\$19.42	\$51.45	\$132,001.63			\$153,916.98	\$186,200.00
August.....	334,898.12	1,138.85	9,351.83	57.13	20.00	132,488.64	\$1,343.75		147,847.40	214,343.89
September.....	311,038.18	1,092.98	7,740.04	111.65	10.00	113,663.95			297,500.08	198,000.00
October.....	243,593.43	1,058.22	10,983.91		3.52	108,221.38	1,689.80		203,438.79	187,000.00
November.....	305,144.28	1,171.21	12,886.02		10.00	106,711.25		\$335.00	290,270.58	178,000.00
December.....	301,327.58	1,269.26	9,508.71		10.00	123,542.65			140,586.18	190,000.00
1916.										
January.....	256,053.25	943.92	8,707.82	1,030.66	.97	90,446.91			132,749.86	157,500.00
February.....	274,254.45	994.20	8,452.97	19.42	63.25	95,661.61			160,994.97	158,500.00
March.....	293,936.37	1,024.91	10,644.15	1.94	5.00	118,236.18	2,064.04		120,694.71	167,500.00
April.....	285,103.99	1,068.94	13,082.58		62.00	118,506.95			188,440.10	185,000.00
May.....	275,931.33	1,018.97	13,442.33	1,707.62	53.00	126,756.34			188,930.32	40,000.00
June.....	263,398.27	996.35	11,957.99	38.83	156.00	125,263.21	881.86	599.50	77,370.30	263,000.00
Total.....	1 3,518,223.83	12,878.29	129,302.20	3,047.64	445.19	2 1,392,441.70	3 5,979.45	4 1,172.02	2,102,740.27	2,125,043.89

1 Includes deposit money orders issued.

2 Includes deposit money orders paid.

3 Includes June, 1915.

4 Excludes June, 1916.

<sup>1</sup> Includes deposit money orders issued.<sup>2</sup> Includes deposit money orders paid.<sup>3</sup> Includes June, 1915.<sup>4</sup> Excludes June, 1916.

TABLE 48.—Statement of money-order business and postal receipts for the fiscal year ending June 30, 1916.

Station.	Number of orders issued.	Amount issued.	Money orders paid at Canal Zone post offices.				Postal receipts.			Total revenue.
			United States.	Canal Zone.	Martini- nique.	Costa Rica.	Stamp sales.	Box rents.	Newspaper postage.	
Ancon.....	38,944	\$686,148.17	\$28,209.64	\$225,921.32	\$303.25	\$310.19	\$21,602.13	\$1,332.00	\$1,410.25	\$27,326.07
Balboa.....	27,520	649,215.07	20,299.45	274,818.50	19.42		8,869.50	614.50		11,575.96
Balboa Heights.....	13,868	347,689.14	7,577.34	158,483.73			4,103.87	919.00		6,276.57
Colon.....	4,691	99,355.21	4,133.17	61,265.01			1,831.64	42.50		2,216.14
Cristobal.....	42,445	860,324.88	27,942.08	263,145.22			22,700.00	1,128.00		27,340.00
Culebra.....	4,475	66,408.84	7,683.73	28,107.13	2,724.97	85.00	2,457.00	151.50	.14	2,863.28
Empire.....	7,095	105,402.52	13,017.23	52,921.64			3,323.00	140.00		3,836.38
Garin.....	8,994	165,218.76	5,022.12	87,908.47			2,964.00	176.00		3,689.74
Las Cascaidas.....	4,965	81,443.11	9,185.99	41,888.47		50.00	3,018.00	51.50		3,327.33
Paraiso.....	11,897	308,665.55	2,251.93	127,553.72			2,801.75	366.50		4,099.65
Pedro Miguel.....	6,202	148,352.58	3,919.52	70,428.49			1,347.53	107.00		1,864.08
Fort Randolph.....							88.25	1.00		89.25
Fort Sherman.....							447.00			447.00
Monte Lirio.....							19.28			19.28
Gamboa.....							444.63			444.63
Storekeeper, Balboa.....							225.00			225.00
Republic of Panama.....							11.50			14.50
Total.....	171,096	1 3,518,223.83	129,302.20	2 1,392,441.70	3,047.64	445.19	76,337.08	5,029.50	1,410.39	95,655.26

<sup>1</sup> Included deposit money orders issued.<sup>2</sup> Included deposit money orders paid.

Station B changed to Fort Sherman May 1, 1916.

Fort Randolph established Apr. 1, 1916.

Monte Lirio reestablished July 1, 1915.

TABLE No. 49.—Statement of postal savings transactions for the fiscal year ended June 30, 1916.

Post office.	Postal-savings certificates.				Deposit money orders.		
	Balance on hand July 1, 1915.	Transfers in.	Transfers out.	Withdrawals.	Balance on hand June 30, 1916.	Issued.	Paid.
Ancon.....	\$40,180	\$2,281	.....	.....	\$40,895	\$150,970	\$141,890
Balboa.....	10,419	.....	.....	.....	73,615	241,150	233,660
Balboa Heights.....	.....	.....	.....	.....	19,860	82,480	81,885
Corozal.....	28,838	.....	.....	.....	32,420	40,315	55,635
Cristobal.....	7,089	4	2,073	256	87,265	186,735	207,480
Culebra.....	.....	.....	.....	.....	6,375	26,820	24,420
Empire.....	.....	.....	.....	.....	8,200	48,920	49,435
Gatun.....	11,440	.....	4	.....	21,850	74,195	75,350
Las Cascaidas.....	.....	.....	.....	.....	9,465	41,240	40,645
Paraiso.....	7,844	.....	.....	.....	33,880	134,675	118,325
Pedro Miguel.....	18,851	.....	.....	.....	19,065	73,690	64,705
Total.....	124,661	2,285	2,285	110,360	352,890	1,101,190	1,103,430

TABLE No. 50.—Statement of receipts and disbursements by the Bureau of Clubs and Playgrounds for the fiscal year 1916.

Clubhouses.	Cash on hand July 1, 1915.	Balance on deposit with collector July 1, 1915.	Receipts July 1, 1915, to June 30, 1916.	Transfer of funds.	Total.	Disbursements July 1, 1915, to June 30, 1916.	Cash on hand June 30, 1916.	Balance on deposit with collector June 30, 1916.	Commissary coupons in transit June 30, 1916.	Total balance available on June 30, 1916.
Ancon.....	\$409.64	\$2,700.32	\$6,604.80	\$21,000.00	\$27,604.80	\$27,246.05	\$175.98	\$182.16	.....	\$358.14
Balboa.....	39.37	5,506.86	41,662.45	4,316.90	49,455.51	58,454.56	691.87	1,275.07	.....	2,000.95
Cristobal.....	302.58	4,965.16	28,777.89	17,000.00	27,344.09	17,021.52	179.30	133.47	.....	322.77
Gatun.....	.....	.....	18,069.73	16,000.00	17,317.49	15,886.79	339.32	990.78	.....	1,330.70
Gatun Silver Club.....	.....	.....	3,207.37	.....	3,207.37	2,320.16	52.46	382.33	.....	887.21
La Boca.....	676.11	808.73	21,111.36	13,000.00	19,596.20	17,280.89	392.56	1,002.92	442.42	2,398.31
Pedro Miguel.....	207.08	540.05	15,378.90	1,000.00	15,126.03	14,755.08	14.75	355.60	823.83	370.35
Superintendent's account.....	193.22	5,030.38	4,200.72	14,000.00	5,484.32	5,207.19	25.00	192.13	.....	217.13
Balboa Yacht Club.....	.....	.....	5,054.64	4,316.90	9,371.54	9,371.54	.....	.....	.....	.....
Total.....	1,848.00	19,491.50	144,067.85	.....	105,407.35	157,610.79	1,871.84	4,624.46	1,300.26	7,796.56
Unpaid audited vouchers June 30, 1916.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Collector's balance, as shown on account current June 30, 1916.....	.....	.....	.....	.....	.....	.....	.....	4,625.21	.....	.....

1 Credits.

TABLE 51.—Receipts by the Bureau of Clubs and Playgrounds, July 1, 1915, to June 30, 1916.

	Ancon.	Balboa.	Cristobal.	Gatun.	Silver Club.	La Boca.	Pedro Miguel.	Superintendent's account.	Total.
Memberships.....	\$1,209.50	\$3,008.00	\$1,913.80	\$1,686.50	.....	\$445.86	\$1,481.50	\$338.06	\$10,173.22
Soda fountains.....	2,197.90	15,120.43	13,972.40	7,877.21	\$2,001.40	9,183.03	6,126.39	1,996.00	58,474.76
Billiards.....	236.06	1,199.32	1,468.85	552.20	185.60	361.57	620.70	120.57	4,744.87
Bowling alleys.....	403.45	890.15	971.70	732.60	.....	.....	572.05	115.75	3,685.72
Salable merchandise.....	112.60	4,736.33	195.94	236.00	.....	19.99	315.90	69.32	5,706.08
Entertainment.....	510.99	2,620.04	619.46	417.94	.....	.....	1,159.02	.....	5,328.05
Motion pictures.....	332.01	2,606.17	1,322.45	2,722.67	.....	.....	2,607.04	665.65	10,915.71
Library deposits and fines.....	46.60	139.93	49.52	24.80	478.24	12.50	42.28	23.28	10,339.21
Activities.....	46.92	228.71	56.00	.....	.....	.....	.....	.....	331.63
Pressing Club.....	.....	814.75	56.00	.....	.....	55.00	.....	24.00	950.75
Tournaments.....	30.00	79.12	165.50	.....	.....	3.25	72.00	.....	349.87
Cigars and candies.....	1,412.29	7,603.52	7,368.61	3,050.22	542.13	10,080.63	1,913.65	897.79	32,898.84
Rentals.....	23.48	113.10	101.00	101.07	.....	84.00	4.25	10.30	32,437.90
Gun Club.....	.....	1,971.62	515.33	.....	.....	.....	.....	.....	2,486.95
Tennis Club.....	13.00	140.50	.....	.....	.....	.....	62.50	.....	216.00
Playgrounds.....	.....	.....	.....	.....	.....	684.05	.....	.....	684.05
Brake services.....	.....	.....	.....	.....	.....	.....	401.02	.....	401.02
Golf Club, salable merchandise.....	.....	.....	.....	543.00	.....	.....	.....	.....	543.00
Fishing tackle.....	.....	.....	.....	65.54	.....	.....	.....	.....	65.54
Balboa Yacht Club.....	.....	319.64	.....	.....	.....	.....	.....	.....	319.64
Balboa Yacht Club (Panama Railroad Company).....	.....	5,000.00	.....	.....	.....	.....	.....	.....	5,000.00
Swimming tank.....	.....	13.76	.....	.....	.....	.....	15.76	.....	15.76
Total.....	6,604.80	46,717.09	28,777.86	18,009.75	3,207.37	21,111.36	15,378.90	4,260.72	144,067.85

TABLE 52.—Disbursements by the Bureau of Clubs and Playgrounds, July 1, 1915, to June 30, 1916.

	Ancon.	Balboa.	Cristobal.	Gatun.	Gatun Silver.	La Boca.	Pedro Miguel.	Superintendent's account.	Total.
Billiards.....	\$229.29	\$679.51	\$671.77	\$212.72	\$33.16	\$132.56	\$451.89	\$51.75	\$2,482.65
Bowling alleys.....	284.25	1,152.92	1,163.44	670.73	.....	.....	559.47	110.94	3,911.75
Entertainments.....	585.60	3,407.68	1,255.43	823.24	.....	79.64	1,649.62	39.56	7,840.77
Motion pictures.....	670.47	2,871.59	1,770.21	1,995.07	367.04	269.24	2,171.15	686.62	10,801.39
Office help.....	271.65	1,043.19	1,297.00	719.90	.....	221.19	774.19	286.72	4,612.94
Library books and periodicals.....	152.80	199.66	217.30	176.55	31.82	153.44	150.20	24.00	1,105.77
Maintenance and general expense.....	507.09	1,789.00	742.83	691.88	89.21	608.57	1,273.64	259.59	5,961.81
Supplies and equipment.....	144.56	5,107.93	674.37	502.12	3.57	133.01	552.12	37.69	1,843.64
Salable merchandise.....	1,456.61	11,313.56	11,961.79	259.40	.....	7,456.03	5,301.65	2,179.18	6,189.22
Soda fountain.....	.....	677.16	51.30	94.53	1,457.71	.....	5,301.65	2.33	825.32
Pressing Club.....	.....	793.41	129.06	46.38	.....	29.99	41.22	13.92	1,092.83
Activities.....	38.55	120.00	48.50	31.50	.....	6.50	52.50	60.00	331.00
Refunds.....	6.00	234.18	237.62	41.68	.....	15.28	97.87	37.41	667.04
Tournaments.....	.....	6,398.56	6,086.17	.....	337.65	7,585.12	1,584.43	770.98	25,892.28
Cigars and candy.....	534.68	2,192.60	469.38	2,424.69	.....	.....	.....	.....	2,661.98
Gun Club.....	.....	78.03	.....	.....	.....	.....	2.50	.....	80.18
Tennis Club.....	1.65	7.70	.....	.....	.....	576.32	.....	.....	584.02
Playgrounds.....	.....	.....	.....	.....	.....	.....	.....	700.00	700.00
Golf Club.....	.....	.....	.....	748.44	.....	.....	.....	.....	748.44
Golf Club, salable merchandise.....	.....	13.00	157.63	.....	.....	.....	.....	.....	170.63
Base ball grounds.....	.....	.....	.....	29.07	.....	.....	.....	.....	29.07
Fishing tackle.....	.....	.....	.....	.....	.....	.....	.....	.....	21,863.47
New buildings.....	21,863.47	.....	.....	.....	.....	.....	.....	.....	299.73
Balboa Yacht Club.....	.....	269.73	.....	.....	.....	.....	.....	.....	269.73
Balboa Yacht Club Building.....	.....	9,371.54	.....	.....	.....	.....	.....	.....	9,371.54
Total.....	27,246.66	47,896.10	27,021.32	15,886.79	2,320.16	17,286.89	14,755.68	5,267.19	157,610.79

TABLE 53.—Statement of amounts paid under the act of May 30, 1908, to employees as compensation and on account of deaths of employees injured in the course of employment, and amounts paid under act of Feb. 24, 1909, for injuries lasting 15 days or less, amounts paid under Executive order of Feb. 26, 1913, and amounts paid under Executive Order No. 1902, dated Mar. 20, 1914, covering period from Aug. 1, 1908, to June 30, 1916.

Total payments, by fiscal years, to date.	Injuries.	Deaths.	Under act of Feb. 24, 1909.	Total.
Aug. 1, 1908, to June 30, 1909.....	\$32,355.71	\$3,682.79	\$8,225.16	\$44,263.66
July 1, 1909, to June 30, 1910.....	96,810.33	21,053.22	16,010.30	133,873.85
July 1, 1910, to June 30, 1911.....	168,416.23	35,248.39	49,957.80	253,622.42
July 1, 1911, to June 30, 1912.....	166,620.21	37,534.68	55,838.25	259,993.14
July 1, 1912, to June 30, 1913.....	150,943.79	23,792.02	49,335.91	224,071.72
July 1, 1913, to June 30, 1914.....	111,240.75	41,015.34	33,704.92	185,961.01
July 1, 1914, to June 30, 1915.....	17,703.40	14,268.97	.....	31,972.37
July 1, 1915, to June 30, 1916.....	168.00	1,206.00	.....	1,374.00
Total.....	744,258.42	177,801.41	213,072.34	1,135,132.17
Payments under Executive order of Feb. 26, 1913.....	.....	.....	.....	13,227.62
Payments under Executive order of Mar. 20, 1914:	.....	.....	.....	.....
Apr. 1, 1914, to June 30, 1914.....	4,283.82	.....	.....	4,283.82
July 1, 1914, to June 30, 1915.....	41,871.91	43,017.71	.....	84,889.62
July 1, 1915, to June 30, 1916.....	32,341.85	33,321.07	.....	65,662.92
Payments made under provisions of contracts between Panama Canal and contractors.....	239.17	.....	.....	239.17
Payments made under special acts of Congress.....	.....	.....	.....	35,218.37
Total.....	.....	.....	.....	1,338,653.69
Amounts paid to Panama Railroad employees:	.....	.....	.....	.....
Apr. 1, 1914, to June 30, 1914.....	770.61	.....	.....	770.61
July 1, 1914, to June 30, 1915.....	10,275.45	2,300.42	.....	12,575.87
July 1, 1915, to June 30, 1916.....	9,056.66	3,330.24	.....	12,386.90
Payments made by Panama Railroad Company for injuries occurring prior to Apr. 1, 1914.....	.....	.....	.....	614.60
Grand total.....	.....	.....	.....	1,365,001.67

TABLE No. 54A.—Statement of amounts paid under Executive Order No. 1902, dated Mar. 20, 1914, as compensation to employees injured and on account of deaths of employees injured while directly engaged in actual work, July 1, 1915, to June 30, 1916.

Department or division.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Total injury.	Total deaths.	Grand total.
Mechanical:															
Injury.....	\$825.27	\$2,531.81	\$714.41	\$325.02	\$391.91	\$1,061.72	\$710.12	\$584.55	\$961.99	\$1,887.38	\$408.55	\$776.82	\$11,379.55	\$6,611.07	\$17,990.62
Death.....				307.92					3,547.54	1,681.82	1,073.79				
General construction:															
Injury.....	44.06	273.70											44.06		
Death.....														273.70	317.76
Supply (quarter-master branch):															
Injury.....	189.44	110.63	89.57	59.43	6.94	131.01	95.49	96.87	112.49	130.71	143.34	84.47	1,250.39	309.53	1,559.92
Death.....							309.53								
Supply (subsistence):															
Injury.....	15.75			2.00											
Death.....						5.63		1.88			4.13	13.31	42.70		42.70
Building construction:															
Injury.....	116.61	101.82	117.70	177.24	458.43	157.98	211.37	80.33	159.42	34.89	446.12	388.51	2,450.62		
Death.....					3,341.11										
Fortifications:															
Injury.....	39.30	82.50	84.30	55.71	79.95	21.60	35.10	66.90	19.20	10.92	105.00	3.00	604.08		
Death.....					584.20									584.20	1,188.28
Health:															
Injury.....	8.46	8.03													
Death.....															
Dredging:															
Injury.....	407.33	783.57	144.74	296.48	123.27	454.62	211.83	257.27	407.97	243.88	211.29	550.10	4,102.35		
Death.....	50.00	359.15			1,370.66	493.46	699.92								
Terminals:															
Injury.....	1,050.16	1,583.77	835.53	793.01	505.45	383.17	1,194.96	596.30	444.16	924.43	465.03	224.44	9,010.41		
Death.....			778.34	469.11	641.49	367.79			200.00	718.47	3,056.52	820.44		7,052.16	16,062.57
Transportation:															
Injury.....	16.00	103.97	67.80		3.00							14.00	207.77		207.77
Death.....															
Municipal engineering:															
Injury.....	68.17	105.72	95.82	62.74	53.88	268.98	24.70	33.25	87.88	67.18	93.85	122.35	1,084.52		
Death.....		1,295.32												1,295.32	2,379.84
Police and fire protection:															
Injury.....							20.00	11.00	10.94	17.19			59.13		
Death.....															59.13
Electrical:															
Injury.....	25.38	31.20	27.12	22.50	25.39	438.23	5.47	4.62	80.25	101.40	113.10	33.15	907.81		
Death.....		153.96							153.96					307.92	1,215.73



Locks:	38.70	30.00	20.00	38.74	74.30	14.50	501.77	7.37	23.75	30.00	3.00	99.47	394.92	8,907.46	9,302.38
Injury.....															
Death.....															
Meteorology and hydrography:															
Injury.....															
Death.....			15.00										15.00		15.00
Marine:															
Injury.....	36.76		25.62	9.62											
Death.....					100.00										
Surveys:							1,565.41		33.63	122.75	43.75	4.82	276.95	1,665.41	1,942.36
Injury.....						10.50	10.13								
Death.....			3.00										23.63		23.63
Accounting:															
Injury.....															
Death.....							73.13	121.88	74.38	20.31			289.70		289.70
Total.....	2,941.39	7,558.15	3,027.95	2,819.52	7,700.27	7,931.41	5,608.93	1,883.85	6,356.91	6,029.70	10,491.74	3,193.10	32,341.85	33,321.07	65,662.92

TABLE No. 54b.—Statement of amounts paid under Executive Order No. 1902, dated Mar. 20, 1914, as compensation to employees injured and on account of deaths of employees injured while directly engaged in actual work with the Panama Railroad Company, July 1, 1915, to June 30, 1916.

Department or division.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.	Total injury.	Total death.	Grand total.
Maintenance of way:															
Injury.....	\$2.70	.....	\$11.70	\$12.00	\$22.80	\$68.04	\$2.40	.....	\$15.90	\$20.70	\$17.40	\$44.58	\$218.22	.....	218.22
Death.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Transportation expenses:															
Injury.....	127.50	206.38	61.05	64.69	150.73	175.71	35.91	78.90	258.88	265.08	381.22	.....	1,806.05	\$601.76	\$2,407.81
Death.....	.....	.....	.....	.....	.....	307.92	203.84	.....	.....	.....	.....	.....	.....	.....	.....
Steveldoring and freight handling, Cristobal:															
Injury.....	181.89	146.99	140.57	95.44	126.36	241.14	288.43	200.16	364.04	245.07	352.07	\$11.73	3,253.89	376.34	3,630.23
Death.....	.....	.....	376.34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Steveldoring and freight handling, Balboa:															
Injury.....	9.00	69.84	102.19	69.99	108.69	225.34	99.36	107.44	77.34	63.28	48.60	12.06	993.13	.....	993.13
Death.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Coal handling:															
Injury.....	87.26	41.58	102.44	95.85	325.02	75.14	23.58	40.22	42.36	39.87	453.42	30.42	1,357.76	.....	.....
Death.....	.....	.....	555.96	.....	.....	1,282.98	.....	.....	.....	.....	.....	.....	.....	.....	.....
Concrete docks, Cristobal:															
Injury.....	55.26	63.90	37.00	6.00	6.30	2.88	91.98	49.17	69.90	32.03	5.38	.....	419.80	1,838.94	3,196.70
Death.....	.....	.....	.....	.....	.....	513.20	.....	.....	.....	.....	.....	.....	.....	513.20	933.00
Commissary operations:															
Injury.....	21.75	25.78	24.76	67.82	16.28	12.75	100.00	155.73	146.80	65.75	128.04	167.35	932.81	.....	932.81
Death.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Concrete freight house, Panama:															
Injury.....	.....	44.07	15.09	.....	.....	.....	.....	.....	.....	.....	.....	.....	59.16	.....	59.16
Death.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lighterage and harbor service:															
Injury.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Death.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total.....	485.36	598.54	1,427.10	411.79	756.78	2,905.10	951.34	691.62	975.22	731.78	1,386.13	1,066.14	9,056.66	3,330.24	12,386.90

TABLE No. 55.—*Injuries for period from July 1, 1915, to June 30, 1916, Panama Canal employees.*

Period of disability.	Monthly rate of pay.										Total.
	Less than \$20.	More than \$20 to \$30.	More than \$30 to \$40.	More than \$40 to \$50.	More than \$50 to \$60.	More than \$60 to \$75.	More than \$75 to \$100.	More than \$100 to \$125.	More than \$125 to \$150.	More than \$150 to \$200.	
More than 7 to 15 days.....	2	104	86	14	11	8	2	11	44	8	294
More than 15 to 30 days.....	5	85	73	12	9	4	5	17	7	1	223
More than 30 to 60 days.....	55	35	11	5	1	1	1	5	7	3	125
More than 60 to 100 days.....	10	9	1	1	1	1	1	1	2	2	26
More than 100 to 200 days.....	8	9	2	1	1	1	1	1	1	1	19
More than 200 to 300 days.....	2	3	3	1	1	1	1	1	1	1	2
More than 300 to 500 days.....	2	3	3	1	1	1	1	1	1	1	5
More than 500 to 1,000 days.....	1	1	1	1	1	1	1	1	1	1	3
More than 1,000 to 1,500 days.....	2	2	1	1	1	1	1	1	1	1	2
More than 1,500 days to 8 years.....	1	1	1	1	1	1	1	1	1	1	14
Total.....	7	266	226	39	28	12	10	22	72	23	713

TABLE No. 56.—*Statement of injuries sustained by employees of The Panama Canal, July 1, 1915, to June 30, 1916, for which compensation was due or claimed under Executive order No. 1902, dated March 20, 1914.*

	Department or division.														Total.
	Mechanical.	General construction.	Supply, quartermaster branch.	Supply, subsistence.	Building construction.	Fortifications.	Health.	Dredging.	Terminals.	Transportation.	Municipal engineering.	Executive.	Electrical.	Locks.	
Injuries reported.....	777	2	96	31	158	43	43	339	557	10	123	15	42	85	2,349
Claims for injuries:															
Filed.....	201	50	8	61	23	18	133	186	3	53	6	16	13	1	785
Approved.....	192	49	7	58	23	16	124	174	3	51	2	16	13	1	741
Disapproved.....	6	1	2	2	2	2	8	10	1	4	1	1	1	1	35
Under 7 days, no allowance.....	576	2	46	23	97	20	25	206	371	7	70	9	26	72	1,564
Pending.....	3	1	1	1	1	1	1	2	1	1	1	1	1	1	9
Accidental deaths reported.....	2	1	1	1	1	1	1	15	9	1	1	1	1	1	39
Claims account death:															
Filed.....	2	1	1	1	1	1	15	9	1	1	1	1	1	1	39
Approved.....	2	1	1	1	1	1	3	5	1	1	1	1	1	1	14
Disapproved.....	1	1	1	1	1	1	1	1	1	1	1	1	1	1	6
Pending.....	1	1	1	1	1	1	11	3	1	1	1	1	1	1	19
Total accidents reported.....	779	2	96	31	159	43	44	354	566	11	124	15	43	89	2,388



TABLE No. 58.—*Injuries for the period from July 1, 1915, to June 30, 1916, Panama Canal employees.*

Character of work at time of injury.	Cause of injury.																									Total.						
	Animals (kicks, bites, falls from, etc.).	Blow of hammer or other object.	Caught between two hard bodies.	Collapse of material.	Contact with fear.	Contact with machinery.	Contact with rough edge or surface.	Contact with sharp instruments, splinters, etc.	Deraillment of locomotive or other moving object.	Explosions (boilers, pipes, gases, etc.).	Explosions (powder, dynamite).	Electric current.	Fall from elevations.	Fall into excavations.	Fall on even surface.	Fall from cars, etc., or other moving body.	Hot metals, inflammable or corrosive substance.	Lifting, pushing, pulling, etc.	Operating hand car.	Struck by flying object.	Struck by moving body (engines, cars, etc.).	Struck by falling body.	Struck by swinging or loose object.	Stepping on nails or other sharp instrument.	Using hand tools or simple instruments.		Vapors, gases, or poisonous substance.	Other causes.				
Aids to navigation.....	1											1											1						48			
Air and water supply.....			10																										4			
Breakwaters and moles.....			11	6		3	1	1	1				18	2	6	1	3	1	2										13	161		
Building construction, repairing, etc.....	1		5			4	2	3					5																64	178		
Docks, quays, wharves, etc.....			14	3		3	4	2					20	2	8		4												20	6		
Drilling and blasting.....																														52	37	
Commissary, storehouses, etc.....			1			1	3	1					1	20	1	4	1	3	10											12	31	
Dry docks and coaling plants.....	8		14	1	2	5	3	13	2				1	20	1	1	1	1	1											37	11	
Electrical installation and operation.....			2			1		1					3	5																4	29	
Excavation, dry, by hand.....			1			1		1																							1	257
Excavation, dry, by machinery.....			4			1		1					1	19	1	1	1	11	2											40	131	
Excavations, wet, dredging, sluicing.....	5		18		2	6	3	15					1	10	1			2												14	89	
Field repairs to equipment, etc.....	6		11		1	4	3	8					2	1	1	5	2	2												6	688	
Fortifications.....			4			1		1	2				2	1	2			2												2	12	
Fuel, messes, operation of.....	1					1		1					2	1																5	21	
Inspection, checking, field.....			5					1					2	1																1	12	
Loading and unloading.....			8		2	4	2	3	1				6	2	6	1	4	3													10	90
Locks and spillways.....	2		7			3	1		1				1	1	1			1	3	1										10	89	
Municipal improvements.....	8					1	2	3	1				1	1				1	5												6	688
Office work, courts, etc.....																															2	12
Plants, manufacturing and repair.....	1	29	32		5	53	12	14					21	3	18		4	33	23												12	33
Quarries, fire protection, etc.....	3												1	1	1	1															2	29
Sanitation, field work of.....			1										1	1	1																6	33
Tracks, construction and maintenance.....			2										1	1	1																1	26
Transportation, railway.....			4										1	1	1																2	29
Transportation, water.....			1										1	1	2		5	4													10	31
Transportation, other.....																															1	5
Other characters of work.....	3		5		1	1		3					5		4	2	2	4													9	107
Total.....	9	67	160	12	15	85	34	86	11	10	5	6	146	15	82	27	72	61	2	255	36	573	80	177	104	20	238	2,388				





TABLE No. 60.—Number of fatal and nonfatal accidents reported from each specified cause for the fiscal years 1908-9, 1909-10, 1910-11, 1911-12, 1912-13, 1913-14, 1914-15, 1915-16.

Cause of injury.	1908-9		1909-10		1910-11		1911-12		1912-13		1913-14		1914-15		1915-16	
	Non-fatal.	Fatal.	Non-fatal.	Fatal.	Non-fatal.	Fatal.	Non-fatal.	Fatal.	Non-fatal.	Fatal.	Non-fatal.	Fatal.	Non-fatal.	Fatal.	Non-fatal.	Fatal.
Animals (kicks, bites, etc.) and riding.	15		14		9		4	1	6		5		5		9	
Caught between two hard bodies.																
Collapse, fall, etc., of materials, etc.	531	10	535	7	738	15	271	7	249	8	174	20	208	1	159	1
Electric current.	3	1	21	5	25	6	11	4	9	2	9	3	4	3	12	
Elevators, hoists, cranes, etc.	61	1	140	9	266	5	111	5	111	7	45	6	7		5	
Explosions of dynamite, powder, etc.	159	44	51	4	35	9	66	11	50	7	11	4	17	7	1	
Falls from ladders, stairs, scaffolding, etc., or into excavations.	91	2	188	5	327	10	114	5	160	13	138	15	237	5	155	6
Falls on even surfaces.	56	1	167		132		146		61		55		105		82	
Flying bodies, splinters, etc.	16		382		667	2	66		95		204		375	3	234	1
Hand tools and simple instruments.	230		251		465	1	153	1	164		114		165		171	
Inflammable, poisonous, hot, corrosive materials, gases, vapors, etc.																
Loading and unloading, lifting, carrying, etc.	31	1	96	1	144		43	1	27	2	35		91		102	
Motors.	280	5	542	1	1,214		371	2	437	1	382	2	238	1	94	1
Operating hand car.	9		4	1	7	1	1		3							
Power-transmission apparatus.	27	1	44	1	52				2		6		30		2	
Railway operation (run over, etc.).	248	41	332	38	488	42	292	37	162	35	165	29	94	4	69	5
Shipping and water transportation.	38	8	32	9	58	8	38	6	13	6	16	4				
Steam boilers, piping, explosions, etc.	43		4		53	1	7		22		10		5			
Stepping on nails and similar sharp bodies.	55		102		225		44		39		15		338		263	
Struck by falling body.																
Struck by swinging or loose object.											47		121	1	79	1
Vehicles (run over by wagons, carts, etc.).	15	1	14	1	57		8		2							
Working machinery using power.	106		91	1	193		91	1	87	1	61		99	1	99	1
Working machinery not using power.	7		9		18		11		13		70		66	15	223	
Other causes.	87		206	3	192	4	101	5	119	2	85	9				
Cause not reported.	1	1	7		11	1			2							
Total.	2,109	119	3,233	85	5,376	105	1,949	86	1,833	84	1,956	97	2,823	47	2,349	39



TABLE No. 61.—Statement of amounts paid by special acts of Congress on account of injuries occurring prior to Aug. 1, 1908.

Name.	Division.	Date injured.	Cause of injury.	Nature of injury.	Amount paid.
Pembroke B. Banton ..	Mechanical.....	Apr. 17, 1906	Rerolling engine; caught under engine.....	Fracture tenth dorsal vertebra; paralysis from hips down.	\$10,000.00
Arthur O. Caswell, heirs of.	do.....	June 1, 1908	Hit by engine when crossing tracks at Gorgona.....	Death.....	1,056.00
Clifford J. Cogan, heirs of.	Chagres.....	May 22, 1908	Premature explosion of dynamite.....	do.....	1,500.00
John H. Cole.....	Culebra.....	May 7, 1908	Operating steam shovel.....	Right hand amputated.....	1,951.38
Robert S. Gill, heirs of..	Atlantic.....	Sept. 30, 1907	S. S. dipper hit side cab; employee hit on side of head.....	Loss of left eye; employee later committed suicide.	2,320.00
Oscar F. Lackey.....	Engineering.....	Nov. 21, 1905	Hit on back by falling timber.....	Injury to back.....	1,500.00
Raymond R. Kidenour.....	Mechanical.....	Nov. 17, 1906	Cleaning machine, when hand caught in same.....	Amputation of thumb and index finger, left.	500.00
F. W. Theodore Schroeter.	do.....	Sept. 28, 1907	While working on car, pair car wheels ran onto him.....	Lacerated ligaments, left knee.....	1,397.66
L. V. Thomas.....	Atlantic.....	No record....	In hospital June 8-12, 1908, traumatic pleuritis; Thomas claimed injury was received about two weeks prior to admission to hospital, caused by lifting heavy timbers.	Partial paralysis (claims injury to back and spine).	1,680.00
Douglas B. Thompson..	Building construction.....	do.....	Admitted to hospital Sept. 20, 1906, myalgia or muscular rheumatism, right foot and ankle; admitted to hospital Dec. 17, 1906, ulcer of leg; Dec. 28, 1906, leg amputated; had varicose veins caused by typhoid fever before entry in service; also claimed malarial fever.	Leg amputated, but no record of injury.	1,500.00
Marcellus Troxwell.....	Central.....	Apr. 7, 1908	Hit by train while working as track foreman.....	Left leg amputated below knee.	1,500.00
Peter W. Wiggington.....	Culebra.....	Nov. 30, 1907	Knocked off from pile driver.....	Fracture right ankle.	500.00
Charles E. Stump, heirs of.	Construction and engineering	Nov. 14, 1905	Fell from dirt train, under wheels.....	Death.....	1,500.00
Alessandro Comba.....	Tracks and dumps.....	Sept. 21, 1907	Hit by engine when crossing tracks.....	Amputation both legs below knee.	500.00
Pedro Sanchez.....	Construction and engineering	Mar. 16, 1908	Premature explosion of dynamite.....	Amputation both hands.....	2,000.00
James P. Martin, heirs of.	Material and supplies.....	Apr. 6, 1906	Hit by engine while walking on track.....	Death.....	1,200.00
William Goodley, mother of.	Central.....	Oct. 8, 1908	Dynamite explosion.....	do.....	1,000.00
John Burrows.....	do.....	Feb. 25, 1909	Hit on side of head with shovel.....	Injury to head followed by general breakdown.	1,433.33
Edward Maher, heirs of.	do.....	June 27, 1907	Train wrecked in Culebra Cut; Maher jumped or was thrown from train and was caught under car.	Death.....	1,980.00
Total.....					35,218.37



TABLE NO. 63.—Comparative statement of store balances, July 1, 1915, and July 1, 1916.

Quartermaster stores (by classes).	July 1, 1915.	July 1, 1916.
Class 1-A. New York air-brake material.....	\$5,729.61	\$7,211.34
1-B. Westinghouse air-brake material.....	23,466.71	28,197.48
2 Mechanical appliances for locomotives and boilers.....	45,648.56	44,243.85
3 Locomotive repair parts.....	53,477.65	58,262.50
4 Car repair parts.....	154,943.25	230,454.22
5 Equipment parts.....	136,498.88	181,703.41
6 Rock, sand, and gravel.....	16,216.28	
9-A. Power-driven shop machines and parts.....	28,057.62	59,015.26
9-B. Pneumatic and electric hand tools.....	27,520.55	31,259.70
9-C. Hand tools.....	40,572.46	57,183.13
9-D. Surveying instruments, typewriters, etc.....	4,979.00	6,627.50
10-A. Tug-boat repair parts.....	20,047.68	25,942.14
10-B. Suction dredge repair parts.....	90,126.24	119,820.29
10-C. Ladder dredge repair parts.....	83,069.28	94,201.32
10-D. Dipper dredge repair parts.....	69,138.47	127,160.53
10-E. Clapet repair parts.....	2,104.20	4,259.65
10-F. Barge repair parts.....	9,021.66	24,639.22
10-G. Marine hardware and equipment.....	9,703.60	25,857.91
11-A. Electric lighting material for buildings, etc.....	131,306.43	132,732.70
11-B. Electric material for locomotives, etc.....	6,581.70	1,085.09
11-C. Electric material for power plants.....	343,336.69	433,139.76
11-D. Telephone, telegraph, and signal material.....	27,961.56	28,501.98
12 Explosives.....	40,411.18	54,352.53
13 Foundry supplies.....	58,093.51	73,282.90
14-A. Iron castings, rough.....	41,817.37	43,033.81
14-B. Steel castings, rough.....	21,276.30	28,013.34
14-C. Brass castings, rough.....	34,952.48	39,433.35
15 Stationery and printing equipment.....	1,496.74	779.09
16 Furniture, hotel equipment, etc.....	29,992.38	32,913.44
17 Corral equipment and supplies.....	25,344.02	35,131.15
18-A. Track material, rail, frogs, etc.....	6,060.91	6,409.39
18-B. Track fastenings.....	19,460.06	16,114.44
18-C. Track tools.....	13,777.74	17,631.02
19 Building material, cement, etc.....	133,720.50	124,643.76
20 Lumber, piling, and ties.....	168,284.09	277,849.48
21 Steel and iron.....	380,841.38	509,178.51
22 Pipe (boiler and condenser tubes).....	65,701.01	120,034.18
23 Pipe fittings.....	146,063.15	164,358.32
24 Metals, brass and copper pipe.....	90,407.56	147,689.29
25 Bolts, nuts, rivets, etc.....	67,545.41	83,850.08
26 Hardware.....	65,943.85	120,833.68
27 Rubber and leather goods.....	123,957.14	224,960.99
28 Paints, oils, drugs, etc.....	124,856.57	188,745.16
29-A. Lubricants and containers.....	27,151.53	55,465.48
29-B. Illuminants, compounds, waste, etc.....	8,041.60	69,719.70
30 Fuel.....	7,192.82	14,781.78
31 Obsolete.....	898.72	70.50
32-A. Scrap, copper, brass, etc.....	3,852.85	20,137.74
32-B. Scrap, all kinds not included in 32-A.....	17,901.77	11,887.54
Total quartermaster stores.....	3,054,615.92	4,202,859.63
Miscellaneous district quartermaster stores.....	20,090.03	7,572.42
Fuel oil.....	99,862.74	95,714.60
Medical store.....	51,815.44	56,178.05
Stationery store, basement.....	11,286.67	12,862.16
Printing plant.....	46,573.55	53,406.43
	3,284,244.35	4,428,593.29

TABLE NO. 64.—C. I. F. cost of material and supplies sold during the year ending June 30, 1916.

	On hand July 1, 1915.	Purchases.	On hand June 30, 1916.	Sold.
Groceries.....	\$273,942.23	\$1,818,994.20	\$320,907.62	\$1,772,028.81
Hardware.....	77,267.26	237,761.91	100,738.92	214,290.25
Dry goods.....	435,428.21	895,391.53	503,161.26	827,658.48
Boots and shoes.....	147,549.56	236,827.86	155,841.52	228,535.90
Cold storage.....	74,726.73	2,121,137.90	134,985.34	2,060,879.29
Tobacco.....	30,295.69	267,699.20	29,738.50	268,256.39
Raw material.....	41,123.16	620,092.43	115,018.18	546,197.41
Total.....	1,080,332.84	6,197,905.03	1,360,391.34	5,917,846.53

TABLE No. 64.—*C. I. F. cost of material and supplies sold during the year ending June 30, 1916—Continued.*

## PERCENTAGE OF SURCHARGE EARNED ON COST.

	Sold.	Earned surcharge.	Percentage earned on cost.
Groceries.....	\$1,772,028.81	\$321,723.16	18.16
Hardware.....	214,290.25	63,664.45	29.71
Dry goods.....	827,658.48	292,824.03	35.38
Boots and shoes.....	228,535.90	64,326.05	28.15
Cold storage.....	2,060,879.29	529,274.31	25.68
Tobacco.....	268,256.39	131,427.35	48.99
Total.....	5,371,649.12	1,403,239.35	26.12

## LOCATION OF PURCHASES.

United States.....	\$4,944,836.79
Foreign.....	661,115.94
Local.....	547,212.41
Panama Canal.....	44,739.89
Total.....	6,197,905.03

## CLASSIFICATION BY COMMODITIES.

Groceries.....	\$1,818,994.20
Hardware.....	237,761.91
Dry goods.....	835,391.53
Boots and shoes.....	236,827.86
Cold storage.....	2,121,137.90
Tobacco.....	267,699.20
Raw material.....	620,092.43
Total.....	6,197,905.03

TABLE No. 65.—*Supply department, commissary branch—Statement showing distribution of sale for the year ending June 30, 1916.*

	Commissary department.	Manufacturing plants.	Total.
To Panama Canal.....	\$1,098,286.71	\$159,575.18	\$1,257,861.89
Panama Railroad.....	43,921.91	16,010.25	59,932.16
Individuals and companies.....	168,296.54	18,560.86	186,857.40
United States Government.....	1,005,022.50	139,266.60	1,144,289.10
Steamships.....	287,771.83	8,027.84	295,799.67
Washington Hotel.....	48,847.04	10,417.12	59,264.16
Paid orders.....	136,027.83	59,454.10	195,481.93
Coupons.....	4,115,283.06	41,850.20	4,157,133.26
Total.....	6,903,457.42	453,162.15	7,356,619.57
Supplied for equipment:			
Commissary expense.....	68,477.82	80,693.41	149,171.23
General expense.....	342.50	511.35	853.85
Plants for expense.....	35,709.78	76,732.93	112,442.71
Total.....	104,530.10	157,937.69	262,467.79
Grand total.....	7,007,987.52	611,099.84	7,619,087.36
Loss by condemnation, shrinkage, etc.....			112,605.88
Loss by clerical errors, pilfering, fire, etc.....			21,209.58
			7,752,902.82

TABLE NO. 66.—Detailed statement of classified expenditures for civil administration and Canal Zone government for the fiscal year ended June 30, 1916, and total from beginning of work to date.

	Zone funds.		Civil administration.		Grand total.	
	Fiscal year 1916.	Total to date.	Fiscal year 1916.	Total to date.	Fiscal year 1916.	Total to date.
Administration.....			\$2,411.91	\$668,280.73	\$2,411.91	\$668,280.73
Supreme and circuit courts.....				396,429.00		396,429.00
Prosecuting attorney.....				39,558.47		39,558.47
District courts (old), magistrates.....	\$1,282.30	\$112,053.80	11,002.08	11,002.08	12,284.38	123,055.88
District courts (new).....			16,557.36	36,902.87	16,557.43	36,902.87
District attorney.....			6,978.74	18,056.49	6,978.74	18,056.49
Canal Zone marshal.....			7,460.45	17,144.58	7,460.45	17,144.58
Division of revenues.....	9.14	60,541.30		196,019.21	9.14	256,560.51
Division of posts.....	7,624.24	581,175.96	113,731.11	1,051,680.78	121,355.35	1,632,856.74
Purchase of stamps.....	22,070.12	322,299.29	19,677.76		41,747.88	322,299.29
Division of customs.....			19,787.98	127,740.52	19,787.98	127,740.52
Division of lands and buildings.....				108,172.17		108,172.17
Division of estates.....			2,417.45	38,433.59	2,417.45	38,433.59
Police and prisons.....	488.13	80,507.04	178,876.62	2,897,932.04	179,364.75	2,978,439.08
Fire protection.....			66,293.46	1,032,938.71	66,293.46	1,032,938.71
Public schools.....	2,664.27	598,611.73	67,206.57	67,206.57	69,870.84	665,818.30
Construction of schoolhouses.....	2,881.68	136,933.52			2,881.68	136,933.52
Repairs of schoolhouses.....	59.82	28,186.36			59.82	28,186.36
Sanitation.....		89,924.15				89,924.15
Zone charity.....	200.00	18,376.90			200.00	18,376.90
Miscellaneous Zone public works.....	7.60	72,286.54		34,825.14	7.60	107,111.68
Treasurer of Canal Zone.....				52,944.05		52,944.05
Construction of buildings.....		20,661.09		549,595.17		570,256.26
Repairs of buildings.....				28,745.75		28,745.75
Survey of lands, Canal Zone.....				75,000.00		75,000.00
Miscellaneous contingent.....	17,199.14	34,677.51			17,199.14	34,677.51
Construction of roads and trails.....	590.11	485,572.91			590.11	485,572.91
Maintenance of roads and trails.....	2,418.06	161,637.82			2,418.06	161,637.82
Construction, water-works and sewers.....		51,965.20				51,965.20
Maintenance, water-works and sewers.....		13,504.02				13,504.02
Special attorney.....				9,206.03		9,206.03
Municipal expenses.....			25.72	25.72	25.72	25.72
Total.....	57,494.61	2,868,915.14	512,427.21	7,457,839.67	569,921.82	10,326,754.81

TABLE No. 67.—Statement of tolls collected July 1 to Sept. 27, 1915.

Vessel.	Nationality.	Date.	Direction.	Bill No.	Tolls collected.	United States registered tonnage.	Panama Canal rules.	
							Tonnage.	Amount.
Aboutir.....	British.....	July 11, 1915	North.....	7125	\$3,336.25	2,669	2,967	\$3,550.40
Do.....	do.....	Aug. 9, 1915	South.....	8099	2,915.00	2,332	2,967	3,550.40
Aguila.....	do.....	Aug. 25, 1915	North.....	7453	732.40	630	627	732.40
Do.....	do.....	Aug. 31, 1915	South.....	7014	772.80	630	644	772.80
Do.....	do.....	Sept. 13, 1915	North.....	9186	732.40	630	627	732.40
Do.....	do.....	Sept. 19, 1915	South.....	9387	768.00	630	640	768.00
Advance.....	American.....	July 19, 1915	do.....	7287	2,063.75	1,651	2,161	2,593.20
Do.....	do.....	July 22, 1915	North.....	7392	2,063.75	1,651	2,161	2,593.20
Do.....	do.....	Aug. 16, 1915	South.....	8212	2,063.75	1,651	2,161	2,593.20
Do.....	do.....	Aug. 18, 1915	North.....	8249	2,063.75	1,651	2,161	2,593.20
Do.....	do.....	July 11, 1915	do.....	7156	2,737.50	2,190	3,120	3,714.00
Aeon.....	British.....	July 11, 1915	do.....	8199	2,737.50	2,190	3,120	3,714.00
Do.....	do.....	Aug. 27, 1915	South.....	8446	2,705.76	3,230	3,758	4,705.76
Alban.....	do.....	Aug. 29, 1915	do.....	7020	3,025.00	2,420	2,670	3,204.00
Alliance.....	American.....	July 4, 1915	do.....	7074	3,025.00	2,420	2,670	3,204.00
Do.....	do.....	July 8, 1915	North.....	8008	3,025.00	2,420	2,670	3,204.00
Do.....	do.....	Aug. 5, 1915	South.....	8062	3,025.00	2,420	2,670	3,204.00
Do.....	do.....	Aug. 13, 1915	North.....	8160	7,810.80	6,812	6,509	7,810.80
Alaskan.....	do.....	July 26, 1915	do.....	7492	4,990.80	4,294	4,159	4,990.80
American.....	British.....	Aug. 26, 1915	North.....	8438	3,780.00	3,024	3,918	4,701.60
American Transport.....	Italian.....	Aug. 16, 1915	South.....	8217	2,779.92	1,261	1,386	2,779.92
Amista.....	American.....	Sept. 10, 1915	North.....	9161	932.80	864	794	932.80
Andrew Welsh.....	Dutch.....	Sept. 4, 1915	South.....	9072	5,558.40	4,685	4,632	5,558.40
Arizona.....	American.....	Aug. 17, 1915	North.....	8243	8,230.80	7,180	6,864	8,230.80
Atna.....	Norwegian.....	Sept. 2, 1915	do.....	9024	3,592.50	2,874	4,516	5,419.20
Aysen.....	Chilean.....	July 17, 1915	South.....	7232	982.50	786	919	1,102.80
Do.....	do.....	Aug. 18, 1915	North.....	8250	2,553.75	2,043	3,042	3,650.40
Do.....	do.....	Aug. 24, 1915	South.....	8298	3,385.00	2,708	3,042	3,650.40
Baron Minto.....	American.....	Aug. 31, 1915	do.....	8639	3,691.25	2,997	3,767	4,515.50
Baron Lovat.....	British.....	July 26, 1915	North.....	7484	5,637.60	4,630	4,698	5,637.60
Baron Tweedmouth.....	do.....	Sept. 9, 1915	South.....	7062	3,701.25	3,213	4,070	5,028.00
Batford.....	do.....	Aug. 1, 1915	do.....	9128	2,875	2,961	4,544	5,552.80
Beckenham.....	do.....	July 16, 1915	North.....	8009	2,525.76	1,875	3,508	4,209.60
Do.....	do.....	Aug. 13, 1915	South.....	7223	4,117.50	3,294	3,508	4,209.60
Bellgrano.....	do.....	July 12, 1915	do.....	7154	3,898.75	3,047	3,587	4,304.40
Do.....	do.....	Aug. 29, 1915	North.....	8533	1,971.75	2,629	3,047	3,587
Benedict.....	do.....	Aug. 21, 1915	South.....	8381			1,483	1,787.76

Berwick Law	do.	Sept. 17, 1915	North	9309	3,673.75	2,939	5,556.00
Birmingham	Danish	July 23, 1915	South	7408	2,202.50	1,834	2,550.80
Do.	do.	Sept. 15, 1915	North	9231	2,292.50	1,834	2,742.00
Bolton Castle	British	Aug. 9, 1915	South	8100	4,611.25	3,689	5,841.60
Bravo	Norwegian	Aug. 31, 1915	do.	8601	1,168.75	935	1,018
Cadiz	British	Sept. 12, 1915	do.	9244	5,403.75	4,323	5,606.40
Calcutta	do.	Aug. 16, 1915	North	8328	1,854.00	1,531	1,854.00
Calliope	do.	Sept. 19, 1915	do.	9308	3,141.25	2,513	3,094
Calicut	do.	July 30, 1915	South	7613	3,169.50	4,226	4,902.00
Camino	American	Aug. 28, 1915	North	8824	2,607.50	2,085	2,207
Cambrian King	British	Sept. 7, 1915	South	9191	2,935.00	2,348	3,558.00
Capac	do.	July 6, 1915	do.	8925	2,545.00	2,036	2,647.20
Do.	do.	Aug. 19, 1915	North	7384	3,661.25	1,972	3,206
Cape Corso	American	July 22, 1915	do.	7384	3,661.25	1,972	3,206
Carlyn	do.	July 6, 1915	South	7085	2,794.80	2,467	2,794.80
Do.	do.	Aug. 15, 1915	North	8185	3,082.50	2,467	3,350.80
Do.	do.	Sept. 15, 1915	South	9256	2,840.40	2,466	2,840.40
Schooner Carib II	Panamanian	Sept. 4, 1915	do.	9073	159.00	212	212
Canea	British	July 21, 1915	do.	7318	714.96	1,868	714.96
Do.	do.	Aug. 10, 1915	North	8127	1,085.00	868	1,091.60
Do.	do.	Aug. 16, 1915	South	8210	1,085.00	868	1,212.00
Do.	do.	Sept. 4, 1915	North	9069	1,085.00	1,011	1,233.20
Do.	do.	Sept. 14, 1915	South	9246	1,085.00	868	1,000
Cedar Branch	do.	Aug. 12, 1915	North	8137	2,777.50	2,222	3,551.20
Chalister	do.	July 15, 1915	South	7197	6,968.80	5,304	6,568.80
Chile	do.	Aug. 15, 1915	North	8186	2,125.00	1,700	2,628
Do.	do.	Aug. 22, 1915	South	9298	2,125.00	1,700	2,628
Charles Nelson (barge)	American	July 29, 1915	do.	7576	730.80	603	730.80
Charlton Hall	do.	Sept. 10, 1915	North	9162	3,750.00	3,000	5,000.40
Chinua	British	Aug. 6, 1915	South	8058	3,476.25	2,781	4,488.00
Chineha	American	July 9, 1915	North	7109	5,137.50	4,110	5,548.80
Do.	do.	Aug. 8, 1915	South	8002	5,137.50	4,110	5,548.80
Do.	do.	Sept. 15, 1915	North	9240	5,137.50	4,110	5,548.80
Chineha	Panamanian	Sept. 7, 1915	do.	9089	7.20	8	7.20
Chipawa	British	Aug. 16, 1915	do.	8241	6,283.20	5,306	6,283.20
City of Bombay	do.	Sept. 8, 1915	South	9120	4,252.50	3,402	5,316.00
City of Corinth	do.	July 13, 1915	do.	7162	5,708.75	4,567	5,970.00
City of Hankow	do.	July 22, 1915	do.	7358	6,917.50	5,531	8,218.80
City of Naples	do.	Sept. 4, 1915	North	9105	4,642.50	3,714	5,661.60
City of Lincoln	do.	Aug. 3, 1915	South	8024	5,511.25	4,409	6,044.40
Civilian	do.	Aug. 28, 1915	do.	8555	6,406.25	5,125	7,630.00
Clan Campbell	do.	Sept. 15, 1915	North	9258	4,600.00	3,680	5,347.20
Clan Ferguson	do.	Aug. 21, 1915	South	8373	5,542.80	4,467	5,542.80
Clan Fergison	do.	July 3, 1915	North	7046	4,282.80	3,467	4,282.80
Clapet 2, 12, and 14	American	Aug. 29, 1915	do.	8645	4,493.00	3,624	4,282.80
Columbian	British	Sept. 13, 1915	do.	9202	2,093.92	1,234	2,093.92
Colon	American	Aug. 25, 1915	North	8489	8,083.20	6,736	8,083.20
Do.	do.	July 1, 1915	South	7147	5,066.40	4,270	5,066.40

1 Ballast.

TABLE No. 67.—Statement of tolls collected July 1 to Sept. 17, 1915.—Continued.

Vessel.	Nationality.	Date.	Direction.	Bill No.	Tolls collected.	United States registered tonnage.	Panama Canal rules.	
							Tonnage.	Amount.
Colon.....	American.....	July 15, 1915	North.....	7193	\$5,066.40	4,193	4,222	\$5,066.40
Colusa.....	do.....	Sept. 16, 1915	do.....	3306	3,071.25	4,037	4,781	3,737.20
Copenhagen.....	British.....	Aug. 13, 1915	do.....	8164	3,637.50	2,910	3,735	4,182.00
Do.....	do.....	Sept. 14, 1915	South.....	9232	3,686.25	2,949	3,735	4,482.00
Coya.....	do.....	Aug. 2, 1915	North.....	8020	2,545.00	2,056	2,216	2,639.20
Do.....	do.....	Sept. 7, 1915	South.....	9123	2,470.00	1,976	2,236	2,683.20
Crown of Galicia.....	do.....	July 31, 1915	do.....	7618	3,438.75	2,739	3,532	4,262.40
Crown of Hall.....	American.....	July 14, 1915	do.....	7196	4,581.25	3,625	4,086	4,903.20
Do.....	British.....	Sept. 13, 1915	North.....	9233	3,975.00	3,180	4,086	4,903.20
Crown of Granada.....	do.....	Sept. 1, 1915	South.....	9062	2,190.00	1,732	2,192	2,630.40
Crown of Navarre.....	do.....	July 8, 1915	North.....	7076	2,806.80	2,409	2,339	2,906.80
Crown of Seville.....	do.....	do.....	South.....	7092	6,097.50	4,878	5,450	6,540.00
Do.....	do.....	Aug. 30, 1915	North.....	8972	4,617.50	3,694	5,595	6,714.00
Curaca.....	do.....	July 12, 1915	South.....	7153	3,437.50	1,650	4,612	3,320.64
Do.....	do.....	Aug. 4, 1915	do.....	8061	5,141.25	4,113	4,612	5,534.40
Dakotan.....	American.....	Aug. 1, 1915	North.....	8004	5,701.20	4,757	4,751	5,701.20
Do.....	do.....	Sept. 4, 1915	do.....	9048	5,701.20	4,757	4,477	3,223.41
De Soto.....	do.....	Aug. 18, 1915	South.....	8253	3,223.44	3,638	3,367	4,040.40
Devian.....	British.....	Aug. 30, 1915	do.....	7271	2,856.25	2,285	123	147.60
Discoverer.....	do.....	Aug. 1, 1915	do.....	8644	4,291.25	3,435	4,320	5,164.00
Donax.....	do.....	Sept. 10, 1915	do.....	8007	2,893.75	2,315	2,785	3,342.00
Durley Chine.....	Dutch.....	Aug. 24, 1915	do.....	9154	2,151.60	1,733	1,793	2,151.60
Earl of Elgin.....	British.....	July 21, 1915	do.....	8427	1,446.25	1,157	1,430	1,716.00
Elma Eburna.....	do.....	Sept. 9, 1915	North.....	7350	3,513.75	2,811	3,910	4,692.00
Edison Light.....	do.....	July 26, 1915	South.....	9135	3,891.25	3,113	3,542	4,250.40
Edith.....	do.....	Aug. 10, 1915	do.....	7495	2,252.50	1,885	2,262	2,620.00
Ellerslie.....	American.....	Aug. 14, 1915	do.....	8106	3,170.40	1,802	2,642	3,170.40
English Monarch.....	do.....	Sept. 13, 1915	do.....	8902	3,205.00	2,564	3,122	3,746.40
Epsom.....	do.....	July 14, 1915	North.....	9250	4,098.75	3,207	5,122	6,146.40
Eureka.....	do.....	July 2, 1915	do.....	7185	1,132.00	3,675	2,018	2,491.60
Falcon.....	do.....	Aug. 21, 1915	South.....	8367	2,230.00	1,784	1,652	1,262.40
Ferrona.....	American.....	July 29, 1915	do.....	7575	2,882.50	1,098	4,008	2,885.76
Do.....	British.....	Aug. 4, 1915	North.....	8037	3,502.76	2,802	4,016	4,819.20
Finchley.....	do.....	Sept. 4, 1915	do.....	9058	3,222.50	2,578	3,573	4,287.60
Finland.....	do.....	July 16, 1915	do.....	7224	9,826.25	7,861	8,485	10,182.00
Do.....	American.....	Aug. 7, 1915	South.....	7351	9,826.25	7,861	8,485	10,182.00
Finn.....	do.....	Sept. 7, 1915	North.....	9083	9,826.25	7,861	8,485	10,182.00
Fiorgyn.....	Norwegian.....	Aug. 1, 1915	do.....	8003	3,091.25	2,473	3,044	3,652.80
Do.....	American.....	July 30, 1915	South.....	7573	139.20	166	116	139.20



Florence.....	do.....	Aug. 19, 1915	North.....	4,121	5,407.20
Francis Hanly.....	do.....	Sept. 16, 1915	do.....	4,506	1,672
Frankmere.....	British.....	July 9, 1915	do.....	9304	1,553
Frederick Luckenbach.....	American.....	July 21, 1915	South.....	4,202	4,206
Do.....	do.....	Sept. 2, 1915	do.....	7317	2,450.40
Frimley.....	British.....	July 31, 1915	do.....	9026	2,984
General Manuel Bonilla.....	Honduran.....	July 11, 1915	do.....	3868	2,752.80
Do.....	do.....	Sept. 11, 1915	do.....	7124	4,641.60
George Howley.....	American.....	Sept. 7, 1915	do.....	7037	264
Georgian.....	do.....	Sept. 7, 1915	do.....	7037	274.80
Gisella.....	do.....	July 18, 1915	North.....	1,700	2,076.00
Good Hope.....	do.....	Aug. 3, 1915	do.....	9084	2,692.80
Grena.....	British.....	Aug. 20, 1915	do.....	8025	5,914.80
Graystone Castle.....	American.....	Aug. 24, 1915	North.....	8931	2,385.60
Grievale.....	Norwegian.....	Sept. 1, 1915	do.....	9020	3,298.40
Guatemala.....	British.....	Aug. 14, 1915	do.....	8183	1,573.20
Do.....	do.....	July 5, 1915	do.....	7047	6,087.60
Guernsey.....	do.....	Aug. 21, 1915	do.....	8498	4,128.00
Do.....	Norwegian.....	Aug. 27, 1915	do.....	8498	5,090.80
Gulna.....	do.....	July 17, 1915	South.....	7302	2,772
Hackensack.....	do.....	Aug. 14, 1915	do.....	8200	3,271
Haigh Hall.....	American.....	July 28, 1915	South.....	7570	3,925.20
Harry Luckenbach.....	British.....	Sept. 5, 1915	do.....	9158	3,356.36
Do.....	do.....	July 29, 1915	do.....	7568	42.00
Hattie Luckenbach.....	American.....	Sept. 1, 1915	do.....	9015	3,230.00
Do.....	do.....	July 23, 1915	do.....	7429	2,487.60
Do.....	do.....	Aug. 24, 1915	do.....	8426	2,290.00
Hawaiian.....	do.....	Aug. 19, 1915	do.....	8327	2,248.75
Hellenic.....	do.....	Aug. 5, 1915	do.....	8073	4,580.40
Henrik.....	Swedish.....	Sept. 8, 1915	do.....	9127	3,385.00
Henry T. Scott.....	Norwegian.....	Aug. 30, 1915	do.....	8576	3,333.75
Hermes.....	American.....	Sept. 12, 1915	do.....	9190	3,057.50
Hesperos.....	Dutch.....	Aug. 17, 1915	do.....	8200	1,141.20
Do.....	British.....	Sept. 15, 1915	do.....	9232	2,977.50
Do.....	do.....	Sept. 15, 1915	do.....	9187	3,403.75
Holly Branch.....	do.....	Sept. 14, 1915	do.....	9125	3,084.08
Holtve.....	do.....	Aug. 13, 1915	do.....	8165	2,723
Honohulan.....	American.....	Sept. 13, 1915	do.....	8165	2,723
Do.....	do.....	Sept. 13, 1915	do.....	8165	2,723
Howick Hall.....	British.....	Aug. 23, 1915	do.....	8419	3,082.32
Huallaga.....	Peruvian.....	Aug. 24, 1915	do.....	8436	6,778.75
Do.....	do.....	Aug. 24, 1915	do.....	8436	5,423
Huasco.....	Chilean.....	July 28, 1915	do.....	8557	3,898.75
Do.....	do.....	Aug. 2, 1915	do.....	8014	1,710.00
Do.....	do.....	Sept. 8, 1915	do.....	9255	2,916.00
Hubert.....	do.....	Sept. 13, 1915	do.....	7553	3,745.20
Idomenus.....	British.....	July 28, 1915	do.....	7090	3,745.20
Do.....	do.....	Sept. 8, 1915	do.....	9053	4,210.80
Do.....	do.....	Sept. 8, 1915	do.....	9053	5,599.60
Inden.....	Danish.....	Aug. 4, 1915	do.....	8040	4,943
					4,960.80

1 Ballast.

TABLE No. 67.—Statement of tolls collected July 1 to Sept. 17, 1915—Continued.

Vessel.	Nationality.	Date.	Direction.	Bill No.	Tolls col- lected.	United States registered tonnage.	Panama Canal rules.	
							Tonnage.	Amount.
Indra.....	British.....	Aug. 31, 1915	North.....	8578	\$4,525.00	3,620	4,931	\$5,917.20
Indradeo.....	do.....	Aug. 17, 1915	South.....	8224	5,017.50	4,038	4,571	5,485.20
Indrakula.....	do.....	July 14, 1915	do.....	7198	4,440.00	3,552	4,923	5,907.60
Ingenieur.....	Dutch.....	Aug. 30, 1915	do.....	8643	3,586.25	160	100	192.00
Inveran.....	British.....	Aug. 23, 1915	North.....	8417	3,586.25	2,853	3,609	4,402.80
Inverclyde.....	do.....	July 12, 1915	do.....	7165	4,485.00	3,588	3,919	4,702.80
Do.....	do.....	Sept. 7, 1915	South.....	9121	3,906.25	3,125	3,933	4,719.60
Invertay.....	do.....	Sept. 1, 1915	North.....	9007	3,202.50	2,552	3,843	4,611.60
Iowan.....	American.....	July 6, 1915	South.....	7045	5,628.00	4,748	4,690	5,628.00
Do.....	do.....	Aug. 22, 1915	North.....	8374	5,640.00	4,748	4,700	5,640.00
Isabella.....	do.....	July 11, 1915	South.....	7148	2,471.25	1,977	2,206	2,647.20
Isthmian.....	do.....	Aug. 11, 1915	North.....	8129	4,770.00	3,975	4,975	4,770.00
Do.....	do.....	Sept. 10, 1915	South.....	9139	4,770.00	4,216	3,975	4,770.00
Jamaica.....	British.....	July 6, 1915	North.....	7052	744.00	630	620	744.00
Do.....	do.....	July 9, 1915	South.....	7104	731.20	630	626	751.20
Do.....	do.....	July 19, 1915	North.....	7245	744.00	630	620	744.00
Do.....	do.....	July 24, 1915	South.....	7435	744.00	630	620	744.00
Do.....	do.....	Aug. 2, 1915	North.....	8022	744.00	630	620	744.00
Do.....	do.....	Aug. 6, 1915	South.....	8069	758.40	630	632	758.40
Do.....	do.....	Aug. 15, 1915	North.....	8187	744.00	630	620	744.00
Do.....	do.....	Aug. 20, 1915	South.....	8332	754.80	630	629	751.80
Do.....	do.....	Aug. 30, 1915	North.....	8377	744.00	630	620	744.00
Do.....	do.....	Sept. 3, 1915	South.....	9182	732.40	630	627	732.40
Do.....	do.....	Sept. 12, 1915	North.....	9302	744.00	630	620	744.00
Do.....	do.....	Sept. 17, 1915	South.....	9302	744.00	630	625	750.00
Do.....	do.....	Sept. 4, 1915	North.....	9061	6,072.50	4,858	5,845	7,014.00
Jason.....	American.....	Sept. 21, 1915	do.....	8371	3,909.60	3,192	3,258	3,909.60
J. L. Isletenbach.....	do.....	July 25, 1915	do.....	7152	1,730.00	1,384	1,536	1,843.20
John A. Hooper.....	do.....	Aug. 22, 1915	South.....	8383	1,730.00	1,384	1,536	1,843.20
Jungshoved.....	Danish.....	Sept. 2, 1915	North.....	9030	3,471.25	2,777	3,133	3,759.60
Jutlandia.....	Swedish.....	July 15, 1915	do.....	7194	4,718.40	3,907	3,932	4,718.40
Karna.....	British.....	Aug. 31, 1915	South.....	8633	3,002.50	2,402	3,054	3,894.80
Do.....	do.....	July 17, 1915	do.....	7233	2,211.25	3,369	3,067	3,080.40
Kenkok Maru.....	Japanese.....	July 10, 1915	do.....	7128	2,833.60	2,515	2,403	2,833.60
Kentra.....	do.....	July 17, 1915	do.....	7251	3,776.25	3,021	4,253	5,103.60
Kentuckian.....	American.....	July 31, 1915	North.....	7048	5,707.20	4,830	4,756	5,707.20
Do.....	do.....	July 4, 1915	South.....	7015	5,707.20	4,830	4,756	5,707.20
Kim.....	Norwegian.....	July 13, 1915	North.....	7174	4,178.75	3,343	3,343	4,085.60
Do.....	do.....	Aug. 7, 1915	South.....	8086	4,085.60	3,313	5,605	6,726.00
Do.....	do.....	Sept. 2, 1915	North.....	9025	4,178.75	3,343	5,605	6,726.00
Kongasan Maru.....	Japanese.....	July 25, 1915	South.....	7491	4,810.00	3,848	4,103	5,031.60

Kronberg.....	Danish.....	Aug. 14, 1915	North.....	2,214	2,715	3,258.00
Kronprinsessan Margareta.....	Swedish.....	July 16, 1915	do.....	7222	4,006	4,807.20
Kronland.....	American.....	July 17, 1915	South.....	7,909	8,551	10,261.20
Do.....	do.....	Aug. 14, 1915	North.....	8,181	8,551	10,261.20
Do.....	do.....	Sept. 4, 1915	South.....	9,063	8,551	10,261.20
Kumi Maru.....	Japanese.....	Aug. 22, 1915	do.....	8,993	3,178	3,813.60
Lady Carrington.....	British.....	July 11, 1915	North.....	7173	3,366	4,039.20
La Habra.....	do.....	Aug. 12, 1915	South.....	8397	2,846	3,415.20
La Plarico.....	Norwegian.....	Aug. 12, 1915	do.....	8142	5,267	6,320.40
Lennon.....	Panaman.....	Aug. 13, 1915	North.....	8276	1,115	10.80
Lewis K. Thurlow.....	British.....	Sept. 13, 1915	do.....	9184	2,708	3,249.60
Do.....	do.....	Aug. 13, 1915	South.....	7289	2,444	2,932.80
Lewis Luckenbach.....	American.....	July 19, 1915	North.....	8435	3,130	3,756.00
Do.....	do.....	Aug. 24, 1915	South.....	7324	3,546	4,255.20
Lewisham.....	do.....	July 27, 1915	North.....	9110	4,253.20	5,028.00
Do.....	do.....	Sept. 8, 1915	South.....	9164	4,253.20	5,028.00
Limar.....	Chilean.....	Sept. 11, 1915	do.....	7183	2,400.00	1,792
Do.....	do.....	July 14, 1915	North.....	7286	2,002.50	1,602
Do.....	do.....	July 19, 1915	South.....	8437	2,002.50	1,602
Do.....	do.....	Aug. 25, 1915	North.....	8588	1,602	2,905.20
Do.....	do.....	Aug. 30, 1915	South.....	8589	2,421	2,905.20
Llangorse.....	British.....	Aug. 29, 1915	do.....	8203	1,317	2,252.40
Lodewijk Van Nassan.....	Dutch.....	Aug. 13, 1915	North.....	9185	2,376	1,710.72
Do.....	do.....	Sept. 13, 1915	South.....	7577	2,376	2,851.20
Lowther Castle.....	British.....	July 29, 1915	do.....	8253	4,387	5,264.40
Luz Blanca.....	do.....	Aug. 18, 1915	North.....	9040	3,136	3,352.86
Do.....	do.....	Sept. 4, 1915	South.....	8046	3,268	3,921.00
Do.....	do.....	Aug. 5, 1915	North.....	9152	4,021	5,545.20
Do.....	do.....	Sept. 8, 1915	South.....	7259	3,458	4,149.60
Magdala.....	Swedish.....	July 17, 1915	do.....	7082	3,826	4,343
Magellan.....	French.....	July 4, 1915	North.....	7455	578	894.00
Manavi.....	British.....	July 25, 1915	South.....	7616	578	894.00
Do.....	do.....	Aug. 23, 1915	North.....	8418	578	894.00
Do.....	do.....	July 31, 1915	South.....	8497	745	894.00
Do.....	do.....	Aug. 29, 1915	North.....	7493	2,038	3,105.60
Do.....	do.....	July 26, 1915	South.....	7049	892	1,045.20
Monaro.....	Swedish.....	July 5, 1915	do.....	7380	3,307	3,968.40
Margaret.....	Norwegian.....	July 30, 1915	North.....	8001	4,330	5,196.00
Mathilda.....	British.....	Aug. 1, 1915	South.....	7396	2,871	3,445.20
Melania.....	do.....	Aug. 1, 1915	North.....	7454	6,715	8,058.00
Merchant.....	American.....	July 25, 1915	do.....	9013	7,108	8,058.00
Mexican.....	do.....	Sept. 1, 1915	South.....	8087	4,137	4,964.40
Mexico.....	British.....	Aug. 6, 1915	do.....	9032	4,137	4,964.40
Do.....	do.....	Sept. 3, 1915	North.....	7459	3,848	4,617.60
Do.....	do.....	July 24, 1915	South.....	9150	4,610	5,532.00
Middleham Castle.....	American.....	July 11, 1915	North.....	9183	4,109	4,932.00
Minnesota.....	do.....	Sept. 13, 1915	South.....	7586	4,294	5,152.40
Do.....	do.....	July 30, 1915	North.....	7170	4,706	5,617.20
Metra.....	British.....	July 13, 1915	South.....	8252	4,706	5,617.20
Montanan.....	American.....	Aug. 18, 1915	do.....	7000	4,398	4,977.40
Do.....	do.....	July 1, 1915	North.....	9153	6,052	8,018.40
Matoppo.....	British.....	Sept. 8, 1915	do.....	9133	6,052	8,018.40
Muratai.....	do.....	do.....	do.....	6,794	6,052	8,018.40

1 Ballast.

TABLE No. 67.—Statement of tolls collected July 1 to Sept. 17, 1915—Continued.

Vessel.	Nationality.	Date.	Direction.	Bill No.	Tolls collected.	United States registered tonnage.	Panama Canal rules.	
							Tonnage.	Amount.
Natal.....	Danish.....	July 1, 1915	North.....	7001	\$3,969.60	3,303	3,303	\$3,969.60
Do.....	do.....	July 24, 1915	South.....	7187	3,256.25	2,405	3,308	3,969.60
Navajo.....	American.....	July 11, 1915	North.....	7126	2,134.80	1,967	1,779	2,134.80
Do.....	do.....	Aug. 17, 1915	South.....	8223	2,258.40	1,967	1,882	2,258.40
Navarino.....	British.....	Aug. 3, 1915	do.....	8203	4,103.75	3,283	4,241	5,089.20
Netherpark.....	do.....	Aug. 14, 1915	do.....	8201	4,219.20	3,395	3,516	4,219.20
Nevedan.....	American.....	July 3, 1915	North.....	7016	3,723.60	3,330	3,103	3,723.60
Do.....	do.....	July 31, 1915	South.....	7617	3,723.60	3,330	3,103	3,723.60
Do.....	do.....	Sept. 7, 1915	North.....	9088	3,723.60	3,330	3,103	3,723.60
Do.....	do.....	Aug. 29, 1915	South.....	8590	3,985.00	3,188	3,579	4,294.80
Newton.....	Swedish.....	July 28, 1915	North.....	7565	776.25	621	682	818.40
Nordstjern.....	British.....	Aug. 1, 1915	South.....	8010	3,980.00	3,184	4,231	5,077.20
Norman Monarch.....	do.....	Aug. 2, 1915	North.....	8021	3,578.75	2,863	3,678	4,413.60
Oakland Grange.....	American.....	July 5, 1915	South.....	7033	1.20	1	1	1.20
Ohio (launch).....	do.....	Aug. 5, 1915	do.....	8051	5,638.80	4,759	4,699	5,638.80
Oldfield Grange.....	British.....	July 8, 1915	North.....	7075	4,633.20	3,781	3,861	4,633.20
Olson & Mahoney.....	American.....	July 19, 1915	do.....	7294	938.40	779	782	938.40
Do.....	do.....	Aug. 30, 1915	South.....	8559	584.25	1,779	1,782	707.04
Orniston.....	British.....	July 30, 1915	do.....	7612	2,933.44	13,170	4,102	2,953.44
Do.....	do.....	Sept. 17, 1915	North.....	9316	3,962.50	3,170	4,192	5,030.40
Ortega.....	do.....	Aug. 31, 1915	do.....	8630	5,641.25	4,513	4,960	5,952.00
Oswald.....	do.....	July 27, 1915	do.....	7531	2,700.00	3,152	3,750	2,700.00
Do.....	do.....	Aug. 27, 1915	North.....	8523	3,940.00	3,152	3,750	4,900.00
Pacifico.....	Peruvian.....	July 8, 1915	do.....	7108	2,967.50	2,374	2,738	3,285.60
Palena.....	do.....	Aug. 11, 1915	South.....	8101	2,967.50	2,374	2,738	3,285.60
Do.....	Chilean.....	July 6, 1915	do.....	7056	2,035.00	1,644	2,527	3,044.40
Do.....	do.....	Aug. 11, 1915	North.....	8150	2,035.00	1,644	2,527	3,044.40
Panama.....	American.....	July 1, 1915	South.....	8213	2,066.40	4,236	4,222	2,066.40
Do.....	do.....	July 25, 1915	North.....	7005	3,066.40	4,236	4,222	3,066.40
Do.....	do.....	July 28, 1915	South.....	7461	3,066.40	4,236	4,222	3,066.40
Panama Transport.....	British.....	July 8, 1915	North.....	7089	4,728.75	3,783	4,617	5,940.40
Do.....	do.....	Sept. 2, 1915	do.....	9029	3,673.75	2,939	3,821	4,985.20
Panam.....	American.....	Sept. 1, 1915	do.....	9021	5,132.50	4,106	4,760	5,712.00
Pedro Christophersen.....	Swedish.....	July 25, 1915	South.....	7490	3,150.00	2,520	3,874	4,648.80
Peru.....	British.....	July 9, 1915	North.....	7110	2,100.00	1,680	2,626	3,151.20
Do.....	do.....	July 19, 1915	South.....	7290	2,100.00	1,680	2,626	3,151.20
Peter H. Crowell.....	American.....	July 6, 1915	North.....	7055	3,072.50	2,458	2,882	3,458.40
Pennsylvania.....	do.....	July 18, 1915	do.....	7244	5,595.60	4,749	4,663	5,595.60
Pielades.....	do.....	Sept. 5, 1915	South.....	9071	3,878.75	3,103	3,308	3,969.60
Polwell.....	British.....	Sept. 7, 1915	do.....	9124	1,555.00	1,244	1,421	1,705.20

Polymeria.....	do.....	Aug. 15, 1915	do.....	8207	1,912.50	1,530	1,630	1,956.00
Potosi.....	do.....	Aug. 21, 1915	North.....	8370	4,082.50	3,226	4,316	5,179.20
Potomac.....	do.....	Sept. 8, 1915	do.....	9106	2,971.25	2,377	2,930	3,516.00
Presidente Sarmento.....	Argentinian.....	July 13, 1915	do.....	7172	1,167.50	(2)	2,335	1,167.50
Queen Anette.....	British.....	July 26, 1915	do.....	7485	3,477.50	2,782	3,382	4,058.40
Queen Elizabeth.....	do.....	July 24, 1915	do.....	7460	2,434.32	2,748	3,381	2,434.32
Do.....	do.....	Aug. 21, 1915	North.....	8372	3,435.00	2,748	3,381	4,057.20
Quilova.....	do.....	July 13, 1915	South.....	7161	2,675.00	2,140	2,848	3,417.60
Do.....	do.....	Aug. 12, 1915	do.....	8136	2,675.00	2,140	2,824	3,388.80
Quilque.....	do.....	July 23, 1915	do.....	7169	2,660.00	2,128	2,821	2,677.20
Do.....	do.....	Sept. 15, 1915	North.....	7407	2,506.25	2,005	2,231	2,677.20
Reading.....	do.....	Aug. 27, 1915	South.....	8501	2,648.16	2,439	3,678	3,648.16
Rivertdale.....	do.....	Aug. 12, 1915	North.....	8135	2,971.25	2,377	2,790	3,348.00
Riverdale.....	do.....	Aug. 18, 1915	South.....	8306	3,466.25	2,773	3,277	3,932.40
River Fort.....	do.....	Aug. 26, 1915	do.....	8300	2,625.84	2,895	3,647	2,625.84
Ruford Hall.....	do.....	Aug. 5, 1915	do.....	8234	5,151.25	4,121	4,982	5,978.40
Saint Quentin.....	do.....	July 3, 1915	do.....	7032	5,883.60	4,736	4,963	5,883.60
Salvador.....	do.....	Aug. 13, 1915	North.....	7018	836.80	706	714	836.80
Do.....	do.....	Aug. 17, 1915	South.....	8038	840.00	706	692	830.40
Santa Catalina.....	American.....	July 6, 1915	North.....	8221	5,290.80	4,325	4,409	5,290.80
Do.....	do.....	Aug. 16, 1915	South.....	7526	3,243.75	1,325	4,409	3,174.48
Do.....	do.....	Sept. 3, 1915	South.....	8240	5,290.80	4,325	4,409	5,290.80
Santa Cecilia.....	do.....	July 1, 1915	do.....	9036	3,243.75	4,325	4,409	5,290.80
Do.....	do.....	Aug. 17, 1915	North.....	7001	5,371.20	4,326	4,476	5,371.20
Santa Clara.....	do.....	July 13, 1915	do.....	8242	5,406.25	4,326	4,962	5,990.40
Do.....	do.....	Aug. 6, 1915	South.....	7171	5,243.75	4,325	5,019	6,022.80
Santa Cruz.....	do.....	Aug. 29, 1915	North.....	8059	5,390.40	4,325	4,492	5,390.40
Do.....	do.....	Sept. 8, 1915	South.....	8532	4,382.50	3,506	3,751	4,301.20
San Francisco.....	do.....	July 19, 1915	South.....	9107	3,695.00	2,956	4,001	5,271.70
Do.....	Swedish.....	Sept. 10, 1915	North.....	7307	3,695.00	2,956	4,001	4,801.20
San Miguel.....	do.....	July 11, 1915	do.....	9163	3,695.00	2,956	4,001	4,801.20
Salandria.....	Danish.....	Sept. 7, 1915	South.....	7123	16.50	1,22	1,22	15.84
Do.....	do.....	Aug. 4, 1915	do.....	7117	4,912.80	4,027	4,094	4,912.80
Sanju Maru.....	Japanese.....	July 17, 1915	do.....	9086	3,875.00	3,942	4,060	4,908.00
S. V. Luckenbach.....	American.....	Sept. 12, 1915	South.....	7240	3,875.00	3,100	4,284	5,140.80
Do.....	do.....	Aug. 4, 1915	do.....	8038	2,846.25	2,277	2,639	3,166.80
Sinaloa.....	Norwegian.....	July 2, 1915	North.....	7031	772.50	1,030	1,682	3,158.40
Siskiyout.....	American.....	Aug. 7, 1915	South.....	8080	392.25	1,323	1,550	385.20
Snowdonian.....	British.....	Sept. 1, 1915	South.....	9004	2,507.74	2,402	3,452	2,507.04
Strathairly.....	do.....	July 22, 1915	North.....	7333	3,538.75	2,831	3,363	4,033.60
Do.....	do.....	Aug. 26, 1915	South.....	8496	2,443.84	2,831	3,397	2,443.84
Strathardle.....	do.....	July 30, 1915	South.....	7635	3,528.75	2,823	3,562	4,310.40
Do.....	do.....	Aug. 7, 1915	South.....	7100	2,476.08	1,302	3,439	2,476.08
Strathendrick.....	do.....	Aug. 7, 1915	North.....	8081	3,536.25	2,845	3,439	4,126.80
Do.....	do.....	Aug. 17, 1915	do.....	8244	3,533.75	2,843	3,392	4,070.40
Strathesk.....	do.....	July 3, 1915	do.....	7015	4,278.00	3,518	3,565	4,278.00

\* Displacement.

1 Ballast.

TABLE No. 67.—Statement of tolls collected July 1 to Sept. 17, 1915—Continued.

Vessel.	Nationality.	Date.	Direction.	Bill No.	Tolls collected.	United States registered tonnage.	Panama Canal rates.	
							Tonnage.	Amount.
Strathfillan.....	British.....	July 31, 1915	North.....	7633	\$3,520.00	2,816	3,382	\$4,059.40
Do.....	do.....	Sept. 1, 1915	South.....	9012	2,435.04	1,816	2,816	2,435.04
Stanley Dollar.....	American.....	July 11, 1915	North.....	7146	1,119.60	956	956	1,119.60
Stella.....	Dutch.....	July 23, 1915	do.....	7409	1,186.25	1,749	1,916	2,299.20
Strombos.....	British.....	Sept. 3, 1915	do.....	9038	5,286.00	4,274	4,405	5,286.00
Student.....	do.....	July 17, 1915	North.....	7925	2,907.50	3,326	2,878	3,456.00
Suecia.....	Swedish.....	Sept. 13, 1915	South.....	9245	3,186.25	2,549	3,986	4,783.20
Sulana.....	American.....	July 24, 1915	do.....	7772	2,956.80	2,212	2,114	2,584.80
Suruga.....	do.....	Aug. 18, 1915	do.....	8299	3,987.50	3,190	3,969	4,762.80
Takata Maru.....	Japanese.....	July 22, 1915	do.....	7356	3,391.25	3,313	3,252	3,902.40
Talawa.....	British.....	Sept. 11, 1915	North.....	9165	3,866.25	3,093	3,232	3,875.40
Tallac.....	American.....	Aug. 16, 1915	do.....	8238	1,498.75	1,199	1,587	1,904.40
Tampico.....	do.....	Aug. 6, 1915	do.....	8064	2,068.75	1,655	1,894	2,272.80
Do.....	do.....	Sept. 13, 1915	South.....	9257	1,927.20	1,655	1,606	1,927.20
Tango.....	do.....	Sept. 13, 1915	do.....	9159	8.40	7	7	8.40
Tasmania.....	Swedish.....	July 20, 1915	North.....	7304	3,187.50	2,550	3,618	4,341.60
Telena.....	British.....	July 15, 1915	South.....	7201	4,621.20	3,889	3,851	4,621.20
Tellus.....	Norwegian.....	Sept. 2, 1915	do.....	9016	5,388.75	4,311	5,934	7,120.80
Terrier.....	do.....	July 19, 1915	North.....	7246	4,020.00	3,216	4,032	4,838.40
Do.....	do.....	Aug. 7, 1915	South.....	8091	2,903.04	1,321	1,403	2,903.04
Do.....	do.....	Sept. 7, 1915	North.....	9085	4,020.00	3,216	4,032	4,838.40
Texan.....	American.....	July 14, 1915	do.....	7184	8,019.60	7,100	6,683	8,019.60
Do.....	do.....	Aug. 24, 1915	South.....	8400	8,019.60	7,100	6,683	8,019.60
Thode Fagelund.....	Norwegian.....	July 31, 1915	do.....	7027	2,581.92	1,386	1,581	2,581.92
Do.....	do.....	Aug. 28, 1915	North.....	8530	4,211.25	3,369	3,586	4,303.20
Tokaf Maru.....	Japanese.....	Sept. 8, 1915	do.....	9109	2,923.75	2,339	2,971	3,565.20
Torsdal.....	Norwegian.....	July 18, 1915	do.....	7243	2,920.00	2,336	2,726	3,271.20
Torrige.....	British.....	Sept. 3, 1915	South.....	9064	2,968.56	3,216	4,123	2,968.56
Towa Maru.....	Japanese.....	Sept. 12, 1915	do.....	9192	2,261.25	1,809	2,012	2,414.40
Torohashi Maru.....	do.....	Aug. 31, 1915	do.....	8590	5,715.00	4,572	5,527	6,632.40
Torooka Maru.....	do.....	July 12, 1915	do.....	7152	6,582.50	5,266	5,551	6,661.20
Toushima Maru.....	do.....	July 2, 1915	do.....	7099	5,707.50	4,566	4,566	6,264.00
Trafalgar.....	British.....	July 30, 1915	North.....	7631	3,655.00	2,924	3,818	4,579.20
Tranquebar.....	Danish.....	Sept. 17, 1915	do.....	3303	3,803.75	2,243	3,203	3,843.60
Trance.....	British.....	July 27, 1915	do.....	7537	3,097.50	2,478	3,803	4,563.60
Do.....	do.....	do.....	do.....	8104	55.00	44	44	55.00
Turnvall.....	do.....	Aug. 23, 1915	do.....	8468	3,482.50	2,762	3,449	4,138.80
Ueyvall.....	Ferrian.....	Aug. 11, 1915	South.....	8128	1,556.00	1,240	2,306	2,647.20
Do.....	do.....	Aug. 15, 1915	South.....	8211	1,556.00	1,240	2,306	2,647.20
Do.....	do.....	Sept. 9, 1915	North.....	9112	1,556.00	1,240	2,306	2,647.20
Do.....	do.....	Sept. 13, 1915	South.....	9251	1,556.00	1,240	2,306	2,647.20

				9017	147.60	123	123	147.60
Ulysses.....	Dutch.....	Sept. 1, 1915	do.....	7574	3,171.25	2,437	3,118	3,741.60
Urubamba.....	Peruvian.....	July 29, 1915	do.....	7574	4,412.50	3,530	4,358	5,229.60
Valdura.....	British.....	July 19, 1915	do.....	7288	4,700.00	3,750	4,814	5,776.80
Valetta.....	do.....	Sept. 11, 1915	do.....	9155	2,884.22	1,158	1,006	2,884.22
Vellore.....	do.....	Aug. 27, 1915	do.....	8628	54.00	1,172	1,156	40.32
Vergana.....	do.....	July 16, 1915	do.....	7200	4,441.25	8,553	4,413	5,295.60
Veturia.....	do.....	Sept. 7, 1915	North.....	9087	4,285.00	3,428	4,320	5,434.00
Do.....	do.....	July 5, 1915	do.....	7072	3,287.52	3,555	1,566	3,287.52
Victoria.....	do.....	Sept. 14, 1915	South.....	9249	39.75	53	150	36.00
Victor & Ethan.....	American.....	Aug. 5, 1915	North.....	8105	2,548.08	2,851	3,539	2,548.08
Volga.....	British.....	Aug. 31, 1915	South.....	8584	4,167.50	2,334	3,684	4,420.80
Volhay.....	do.....	July 14, 1915	do.....	7436	4,706.25	3,765	4,226	5,063.20
Wakasa Maru.....	Japanese.....	July 9, 1915	do.....	7116	4,003.75	3,203	3,763	4,515.60
Walton Hall.....	British.....	Aug. 28, 1915	North.....	8529	1,583.75	1,267	1,504	1,804.80
Wellington.....	do.....	July 10, 1915	do.....	7122	3,488.75	2,791	3,571	4,285.20
Westminster.....	do.....	Sept. 8, 1915	South.....	9126	6,516.25	5,213	5,891	7,069.20
Whakarua.....	do.....	July 4, 1915	do.....	7036	3,530.00	2,824	3,560	4,272.00
Whitgift.....	do.....	Aug. 18, 1915	do.....	8227	548.75	439	921	1,105.20
Willapa.....	American.....	Aug. 21, 1915	North.....	8368	4,896.25	3,917	4,279	5,134.80
William O'Brien.....	do.....	Sept. 3, 1915	do.....	9050	4,058.75	3,247	3,888	4,605.60
Yeddo.....	British.....	July 11, 1915	South.....	7149				

1 Ballast.

2 Additional United States net register.

TABLE No. 67A.—Statement of tolls collected Sept. 18, 1915, to June 30, 1916.

Vessel.	Nationality.	Date.	Bill No.	Tolls collected.	United States registered tonnage.	Panama Canal rules.	
						Tonnage.	Amount.
Adea.....	American.....	Dec. 19, 1915	C-2539	1 \$93.60	88	78	\$93.60
Acajula.....	British.....	Sept. 19, 1915	C-2234	1 768.00	630	2 640	768.00
Arabien.....	Danish.....	Apr. 17, 1916	C-2868	4,503.75	3,603	24,693	5,631.60
Alma.....	American.....	Apr. 18, 1916	C-2869	17.20	6	6	7.20
Acajula.....	British.....	May 20, 1916	C-3087	1 759.60	650	2 633	759.60
Alfred Nobel.....	Norwegian.....	May 22, 1916	C-3102	3,093.84	3 2 799	4 297	3,093.84
Aysen.....	Chilean.....	May 23, 1916	C-3107	2 533.75	2,043	3,042	3,650.40
Adriatic.....	British.....	May 24, 1916	C-3113	2 401.25	1 921	2 390	2 868.00
Australien.....	Danish.....	June 2, 1916	C-3186	4 238.75	3 391	5 336	6,403.20
Artisan.....	American.....	June 12, 1916	C-3247	4 595.00	3 166	4 320	5 194.80
Amor.....	Dutch.....	June 23, 1916	C-3320	11 163.52	8 1 468	1 663	1 163.52
Acajula.....	British.....	June 24, 1916	C-3323	1 732.40	650	627	752.40
Admiralen.....	Norwegian.....	Dec. 19, 1915	B-1856	1 132.50	906	1 068	1 281.60
A. J. West (schooner).....	American.....	Jan. 17, 1916	B-1879	483.75	387	2 846	1 015.20
Adea.....	do.....	Mar. 17, 1916	B-2011	93.60	88	78	93.60
Alfred Nobel.....	Norwegian.....	Apr. 13, 1916	B-2075	3 500.00	2 800	4 297	5 156.40
American.....	American.....	Apr. 16, 1916	B-2100	4 443.00	3 556	4 153	4 983.60
Andijk.....	Dutch.....	Apr. 22, 1916	B-2137	5 076.25	4 061	4 632	5 538.40
Alaskan.....	American.....	May 1, 1916	B-2170	6 902.50	5 532	6 703	8 043.60
Artisan.....	do.....	May 9, 1916	B-2196	4 595.00	3 676	4 339	5 194.80
Acajula.....	British.....	May 16, 1916	B-2226	1 732.40	650	627	752.40
Aysen.....	Chilean.....	May 17, 1916	B-2252	2 533.75	2 043	3 042	3 650.40
Albora.....	British.....	May 23, 1916	B-2259	2 932.50	2 850	3 689	4 426.80
Aboukir.....	do.....	June 2, 1916	B-2350	4 578.75	3 663	2 967	3 560.40
Abores.....	Norwegian.....	June 17, 1916	B-2356	3 498.75	3 663	4 329	5 194.80
Alfred Nobel.....	British.....	June 20, 1916	B-2358	487.50	2 799	4 297	5 156.40
Acajula.....	do.....	June 22, 1916	B-2367	3 226.25	2 581	3 485	4 182.00
Ango Australien.....	Chilean.....	June 28, 1916	B-2388	2 533.75	2 043	3 042	3 650.40
Ayson.....	American.....	Feb. 4, 1916	C-2645	1 207.60	173	173	207.60
Barge No. 149.....	do.....	do.....	C-2646	1 208.80	174	174	208.80
Barge No. 150.....	do.....	do.....	C-2653	1 208.80	174	174	208.80
Barge No. 2.....	do.....	do.....	C-2654	1 741.25	1 393	1 806	2 167.20
Burlington.....	do.....	Apr. 29, 1916	C-2937	1 580.40	2 195	1 580	1 580.40
Barge No. 93.....	do.....	May 1, 1916	C-2963	1 378.00	389	315	378.00
Balboa.....	British.....	May 16, 1916	C-3054	2 940.00	2 352	3 548	4 548.40
Barister.....	American.....	May 18, 1916	C-3081	4 923.75	3 939	5 398	6 477.60
Bradford.....	Russian.....	May 21, 1916	C-3093	1 737.50	1 390	1 798	1 798.80
Bakal.....	American.....	May 27, 1916	C-3129	1 378.00	38	315	378.00
Balboa.....	British.....	June 3, 1916	C-3189	4 623.75	3 699	4 963	5 955.60
Bolton Castle.....	American.....	June 4, 1916	C-3203	1 394.80	3 389	2 329	5 394.80
Balboa.....	do.....	June 21, 1916	C-3302				



Beckenham.....	British.....	June 22, 1916	C-3308	3,631.25	2,905	3,598	4,209.60
Bellgrano.....	do.....	June 26, 1916	C-3334	3,808.75	3,047	3,587	4,204.40
Barge No. 2.....	American.....	Apr. 11, 1916	B-2107	1,210.00	175	175	175
Barge No. 13.....	do.....	Apr. 10, 1916	B-2108	131.25	175	175	126.00
Barge No. 21.....	do.....	do.....	B-2109	1,210.00	175	175	210.00
Barge No. 149.....	do.....	do.....	B-2110	1,207.60	173	173	207.00
Barge No. 150.....	do.....	do.....	B-2111	1,207.60	173	173	207.00
Bantu.....	do.....	do.....	B-2112	3,320.00	2,656	3,047	3,656.40
British Empire.....	do.....	Apr. 22, 1916	B-2136	3,320.00	2,656	3,047	3,656.40
Bradford.....	British.....	Apr. 27, 1916	B-2157	1,313.75	255	280	3,350.00
Bradford.....	American.....	May 3, 1916	B-2172	3,886.56	3,403	5,398	3,886.56
Bellgrano.....	British.....	May 3, 1916	B-2195	3,806.75	3,047	3,587	4,304.40
Balboa.....	American.....	May 12, 1916	B-2196	3,806.75	3,047	3,587	4,304.40
Bertrand.....	British.....	May 13, 1916	B-2213	2,832.50	2,282	3,385	3,385
Baron Ogilvy.....	do.....	May 15, 1916	B-2217	3,635.00	2,908	3,812	4,052.00
Birkhall.....	American.....	May 31, 1916	B-2267	1,378.00	389	315	378.00
Balboa.....	British.....	May 26, 1916	B-2268	3,413.75	2,731	3,359	3,359
British Yeoman.....	do.....	do.....	B-2269	2,185.20	1,821	1,821	4,030.80
Bogota.....	do.....	June 5, 1916	B-2268	3,671.25	2,937	4,491	2,185.20
Balboa.....	American.....	June 14, 1916	B-2324	1,378.00	389	315	5,389.20
Do.....	do.....	do.....	B-2339	13.20	(4)		378.00
Bradford.....	do.....	June 24, 1916	B-2370	4,925.75	3,939	5,398	6,477.60
Canal Zone Launch No. 691.....	do.....	Jan. 14, 1916	C-2590	11.20	1	1	7.20
China.....	Panama.....	Mar. 17, 1916	C-2763	17.20			7.20
Chimut.....	British.....	Apr. 16, 1916	C-2855	3,476.25	2,781	3,941	4,729.20
City of Sparta.....	do.....	Apr. 18, 1916	C-2872	4,406.25	3,525	4,310	5,172.00
City of Vienna.....	do.....	Apr. 20, 1916	C-2886	4,912.50	3,930	5,692	6,722.40
Cassia.....	do.....	May 1, 1916	C-2962	3,706.25	3,013	3,622	4,346.40
Charlton Hall.....	American.....	May 9, 1916	C-2997	3,750.00	3,000	2,440	5,280.00
City of Naples.....	British.....	May 11, 1916	C-3016	1,642.50	3,714	2,857	5,828.40
Cauca.....	do.....	May 13, 1916	C-3034	1,085.00	868	998	1,197.60
Capac.....	do.....	May 26, 1916	C-3128	2,456.25	1,965	2,264	2,716.80
Copenhagen.....	do.....	May 30, 1916	C-3160	3,637.50	2,910	3,735	4,482.00
Caspian.....	do.....	May 31, 1916	C-3160	1,938.96	3,317	2,693	1,938.96
Chile.....	do.....	June 3, 1916	C-3196	2,450.00	1,960	2,229	2,734.80
Cushing.....	do.....	June 5, 1916	C-3208	2,125.00	1,700	2,628	3,153.60
Cauca.....	American.....	June 6, 1916	C-3220	5,400.00	4,320	1,869	5,842.80
Cela.....	do.....	June 8, 1916	C-3231	1,078.75	863	998	1,197.60
City of Colombo.....	do.....	June 14, 1916	C-3263	3,900.00	3,192	2,406	5,275.20
City of Panama.....	British.....	June 17, 1916	C-3284	4,366.80	3,187	2,306	4,366.80
City of Norwich.....	American.....	June 18, 1916	C-3285	4,905.00	3,924	2,685	5,073.60
City of Durham.....	British.....	do.....	C-3287	2,703.75	2,153	2,478	2,970.80
Columbia.....	do.....	June 22, 1916	C-3307	5,160.00	4,198	5,814	6,960.80
Carlb II.....	Danish.....	June 25, 1916	C-3336	4,337.50	3,470	2,159	5,970.80
Cetiana.....	Panama.....	Jan. 11, 1916	B-1887	4,498.75	3,499	5,659	5,988.80
Crown of Seville.....	British.....	Apr. 13, 1916	B-2073	1,132.64	315	212	6,790.80
Consols.....	do.....	Apr. 17, 1916	B-2066	780.00	639	780	132.64
Copenhagen.....	do.....	Apr. 17, 1916	B-2101	4,611.25	3,689	5,621	780.00
Capac.....	do.....	Apr. 16, 1916	B-2117	3,001.25	2,401	3,445	6,748.80
Coya.....	do.....	Apr. 17, 1916	B-2125	3,637.50	2,910	3,735	4,134.00
do.....	do.....	Apr. 22, 1916	B-2134	2,436.25	1,965	2,266	4,482.00
do.....	do.....	do.....	B-2134	2,430.00	1,960	2,216	2,647.20

4 Balance on bill No. B-2321.

3 Ballast.

2 Panama Canal, including deck load.

1 Panama Canal.

TABLE No. 67A.—Statement of tolls collected Sept. 18, 1915, to June 30, 1916—Continued.

Vessel.	Nationality.	Date.	Bill No.	Tolls collected.	Panama Canal rules.	
					United States registered tonnage.	Amount.
Cushing.....	American.....	Apr. 25, 1916	B-2143	\$5,400.00	4,320	\$5,842.80
Celia.....	British.....	.....do.....	B-2144	3,990.00	3,192	5,252.40
Clumberhall.....	do.....	Apr. 27, 1916	B-2154	2,888.75	2,311	3,493.20
China.....	American.....	Apr. 29, 1916	B-2160	5,103.75	4,083	5,548.80
Cauca.....	British.....	May 7, 1916	B-2187	1,078.75	863	1,197.60
Chipana.....	do.....	May 9, 1916	B-2198	16,283.20	5,257	6,283.20
Crown.....	do.....	May 10, 1916	B-2200	3,425.00	2,740	4,097.40
Callope.....	do.....	May 11, 1916	B-2208	3,103.75	2,483	3,728.40
California.....	American.....	May 15, 1916	B-2219	8,121.25	4,897	7,256.40
Cumberland.....	British.....	May 21, 1916	B-2242	7,177.50	5,742	6,047.80
Crown of Toledo.....	do.....	May 22, 1916	B-2246	4,605.00	3,684	5,106.00
Chian Alpine.....	do.....	May 24, 1916	B-2255	2,856.25	2,285	2,564.80
Chile.....	do.....	May 28, 1916	B-2264	2,125.00	1,700	2,628.80
Cauca.....	do.....	June 2, 1916	B-2290	1,078.75	863	1,197.60
Curaca.....	do.....	June 6, 1916	B-2307	5,120.00	4,066	5,534.40
China.....	do.....	June 8, 1916	B-2313	3,588.75	2,871	3,725.40
Carpenteria.....	do.....	June 10, 1916	B-2325	4,730.00	3,784	4,470.00
City of Para.....	American.....	June 13, 1916	B-2332	2,703.75	2,163	2,930.80
California.....	do.....	June 22, 1916	B-2363	1,160.20	923	1,141.20
Cauca.....	British.....	June 29, 1916	B-2389	1,078.75	863	1,197.60
Caspian.....	do.....	June 30, 1916	B-2394	2,806.25	2,317	3,231.60
Diana.....	American.....	Jan. 1, 1916	C-2374	1,240.00	2	2.40
Do.....	do.....	Jan. 30, 1916	C-2375	3.60	3	3.60
Delagoa.....	Danish.....	June 8, 1916	C-2325	2,812.30	2,274	4,112.40
Don Benito.....	British.....	June 24, 1916	C-3325	3,018.75	2,415	3,721.20
Deli.....	Dutch.....	June 28, 1916	C-3347	5,470.00	4,769	5,722.80
Dakotan.....	American.....	Apr. 18, 1916	B-2128	5,946.25	4,757	6,019.20
Derwent River.....	British.....	May 29, 1916	B-2272	3,752.50	3,002	4,602.00
De Soto.....	American.....	May 31, 1916	B-2283	4,547.50	3,638	5,372.40
Dorset.....	British.....	June 6, 1916	B-2305	6,058.75	4,847	7,687.20
Eseabal.....	American.....	Mar. 6, 1916	C-2734	1,240.00	2	2.40
Eureka.....	do.....	Apr. 14, 1916	C-2852	12,071.20	1,784	2,071.20
Ellen.....	Norwegian.....	May 11, 1916	C-3017	3,092.50	2,474	4,056.00
Ellerlic.....	British.....	May 15, 1916	C-3051	2,918.75	2,335	3,319.20
Eurymachus.....	do.....	May 27, 1916	C-3132	4,017.50	3,214	4,927.20
Euryades.....	do.....	June 6, 1916	C-3219	4,525.00	3,620	6,055.20
Edgar F. Luckenbach.....	American.....	June 17, 1916	C-3283	17,514.40	6,253	7,514.40
Edison Light.....	do.....	Dec. 19, 1915	B-1857	2,252.50	1,802	2,896.80
Edith.....	do.....	Apr. 15, 1916	B-2114	13,357.60	2,744	3,337.60
Elm Branch.....	British.....	June 17, 1916	B-2345	1,036.00	2,546	3,036.00
Florentino.....	do.....	May 8, 1916	C-3004	2,830.00	2,264	3,405.60
Ferrona.....	do.....	May 18, 1916	C-3076	3,502.50	2,802	4,906.80

Palstria.....	Danish.....	Apr. 16, 1916	C-2856	3,763.75	3,011	3,470	4,164.00
Foreris.....	British.....	Apr. 17, 1916	C-2867	3,196.25	2,557	3,424	4,108.80
Frankly.....	do.....	June 14, 1916	C-3264	3,280.00	2,624	3,812	4,571.40
Florence Luckenbach.....	American.....	June 20, 1916	C-3267	5,131.25	4,121	4,887	5,864.40
Do.....	do.....	June 16, 1916	B-2087	5,131.25	4,121	4,506	5,407.20
Foreris.....	British.....	June 4, 1916	B-2296	3,196.25	2,557	3,110	3,732.00
Florentino.....	do.....	June 28, 1916	B-2391	2,830.00	2,264	2,888	3,403.60
Gilgat.....	do.....	Apr. 14, 1916	C-2851	4,471.25	3,577	4,561	5,473.20
Guatemala.....	do.....	Apr. 26, 1916	C-2908	2,282.50	1,826	2,772	3,326.40
Gozan Maru.....	Japanese.....	May 3, 1916	C-2970	1,746.25	1,631	2,034	2,452.80
General Hubbard.....	American.....	May 13, 1916	C-3003	2,348.75	1,870	2,548	3,057.60
Greenwich.....	British.....	May 21, 1916	C-3100	2,482.75	3,267	2,980	3,661.60
Guernsey.....	Norwegian.....	June 5, 1916	C-3213	2,482.50	1,826	2,772	3,326.40
Guatemala.....	British.....	June 21, 1916	B-2102	3,162.50	2,536	3,492	4,178.40
Gwladys.....	do.....	Apr. 17, 1916	B-2130	2,282.50	1,826	2,772	3,326.40
Guatemala.....	do.....	Apr. 20, 1916	B-2218	2,885.00	2,336	2,607	3,236.20
Good Hope.....	Norwegian.....	May 15, 1916	B-2230	3,925.20	3,346	3,271	3,925.20
Guernsey.....	British.....	May 17, 1916	B-2230	2,282.50	1,826	2,772	3,326.40
Guatemala.....	British.....	June 13, 1916	B-2257	3,947.50	3,158	3,675	4,410.00
Hartima Maru.....	Japanese.....	Apr. 16, 1916	C-2857	3,212.50	2,570	3,479	4,174.80
Hartwood.....	British.....	Apr. 29, 1916	C-2938	2,600.00	2,080	3,121	3,745.20
Huasco.....	Chilean.....	May 9, 1916	C-2999	1,710.00	1,368	2,430	2,916.00
Hualaga.....	Peruvian.....	May 16, 1916	C-3056	3,683.75	2,947	3,878	4,653.60
Hawthead.....	British.....	May 18, 1916	C-3077	3,915.00	3,132	4,508	5,409.60
Hawick Hall.....	American.....	May 27, 1916	C-3131	1,710.00	1,368	2,430	2,916.00
Hualago.....	Peruvian.....	June 13, 1916	C-3258	2,834.64	2,736	3,937	4,834.64
Herkles.....	Norwegian.....	June 20, 1916	C-3298	2,600.00	2,080	3,121	3,745.20
Hesperos.....	Chilean.....	June 24, 1916	C-3301	3,084.08	2,734	4,214	5,034.08
Harry Luckenbach.....	Norwegian.....	Apr. 13, 1916	B-2103	2,248.75	1,799	2,144	2,572.80
Huasco.....	do.....	May 3, 1916	B-2192	2,600.00	2,080	2,584	3,336.00
Huakensack.....	British.....	May 11, 1916	B-2205	1,710.00	1,368	2,430	2,916.00
Hualaga.....	Peruvian.....	May 17, 1916	B-2229	3,403.75	2,723	4,214	5,056.80
Hesperos.....	Norwegian.....	May 19, 1916	B-2239	3,405.00	2,724	4,937	5,916.00
Herkles.....	do.....	June 7, 1916	B-2312	1,710.00	1,368	2,430	2,916.00
Hualaga.....	Peruvian.....	June 14, 1916	B-2338	2,600.00	2,080	3,121	3,745.20
Huasco.....	Chilean.....	June 15, 1916	B-2378	2,523.75	2,019	2,773	3,326.40
Iquitos.....	Peruvian.....	May 3, 1916	C-3053	2,043.75	1,635	2,397	2,876.40
Imperial.....	Chilean.....	May 16, 1916	C-3130	3,590.00	2,846	3,980	4,726.80
Inverkip.....	British.....	May 27, 1916	C-3248	1,862.00	3,541	3,973	4,862.00
Isthunian.....	American.....	June 12, 1916	B-2107	2,762.40	2,331	2,302	2,762.40
Ikoma Maru.....	Japanese.....	May 9, 1916	B-2204	2,043.75	1,635	2,397	2,876.40
Imperial.....	Chilean.....	May 11, 1916	B-2361	2,043.75	1,635	2,397	2,876.40
Do.....	do.....	June 21, 1916	C-3537	2,162.50	1,760	2,960	3,502.00
Do.....	do.....	June 26, 1916	C-2831	3,900.00	3,132	3,258	3,909.00
Jacob Luckenbach.....	American.....	Apr. 10, 1916	C-2831	1,744.00	1,339	2,013	2,415.60
J. L. Luckenbach.....	do.....	May 1, 1916	C-2858	1,744.00	1,339	2,013	2,415.60
John A. Hooper.....	do.....	May 15, 1916	C-3048	1,744.00	1,339	2,013	2,415.60
Jamaica.....	British.....	May 16, 1916	C-3053	1,744.00	1,339	2,013	2,415.60
Do.....	do.....	May 29, 1916	C-3137	1,744.00	1,339	2,013	2,415.60
Do.....	do.....	June 17, 1916	C-3276	1,744.00	1,339	2,013	2,415.60

a Ballast.

b Panama Canal tonnage, including deck load.

1 Panama Canal.

TABLE No. 67A.—Statement of tolls collected Sept. 18, 1915, to June 30, 1916—Continued.

Vessel.	Nationality.	Date.	Bill No.	Tolls collected.	United States registered tonnage.	Panama Canal rules.	
						Tonnage.	Amount.
Jamaica.....	British.....	May 14, 1916	B-2220	1,874.00	630	620	\$744.00
do.....	do.....	May 25, 1916	B-2256	472.50	3,630	620	446.40
Jacob Luckenbach.....	American.....	May 31, 1916	B-2282	2,162.50	1,730	1,980	2,332.00
Jamaica.....	British.....	June 13, 1916	B-2323	1,744.00	630	620	744.00
John A. Hooper.....	American.....	June 26, 1916	B-2376	1,748.55	1,399	1,713	2,055.60
Kenil, Jr.....	do.....	Jan. 30, 1916	C-2624	7.20	6	6	7.20
Kenira.....	do.....	Apr. 24, 1916	C-2889	3,776.25	3,021	2,423	5,151.60
Kioto.....	British.....	May 7, 1916	C-2887	3,040.00	4,032	3,576	6,601.20
Kim.....	Norwegian.....	May 13, 1916	C-3032	1,435.60	3,474	5,005	4,635.60
Kumetic.....	British.....	May 15, 1916	C-3050	5,020.00	4,016	6,600	7,192.00
Kaliber.....	do.....	May 19, 1916	C-3084	3,941.25	3,153	3,852	4,658.40
Kufue.....	do.....	June 24, 1916	C-3326	4,907.50	3,926	5,253	6,303.60
Kangaroo.....	do.....	June 27, 1916	C-3345	3,592.50	2,874	3,204	3,844.80
Kate (launch).....	American.....	Dec. 18, 1915	B-1944	11.20	1	1	1.20
Kim.....	Norwegian.....	Apr. 16, 1916	B-2089	4,342.50	3,474	5,005	6,726.00
Kentuekian.....	American.....	May 13, 1916	B-2211	5,106.25	4,085	4,891	5,869.20
Kim.....	Norwegian.....	June 10, 1916	B-2318	4,342.50	3,474	5,005	6,726.00
King Makomb.....	British.....	June 16, 1916	B-2344	3,536.25	2,829	3,642	4,370.40
Kintuck.....	do.....	June 21, 1916	B-2364	3,786.25	3,029	3,416	4,099.20
Limalie.....	Peruvian.....	Mar. 17, 1916	C-2764	1,218.40	2	2	218.40
Lewis Luckenbach.....	American.....	Apr. 10, 1916	C-2832	4,025.00	3,220	3,492	4,190.40
Luz Blanca.....	British.....	Apr. 16, 1916	C-2854	3,875.00	3,100	3,208	3,921.60
Limari.....	Chilean.....	Apr. 25, 1916	C-2907	2,002.50	1,602	2,421	2,905.20
Lord Derby.....	British.....	Apr. 28, 1916	C-2927	3,001.25	2,401	3,588	4,305.60
Limari.....	Chilean.....	June 5, 1916	C-3209	2,002.50	1,602	2,421	2,905.20
Lewisiam.....	British.....	June 28, 1916	C-3346	2,231.25	1,785	2,213	2,655.60
Limari.....	Chilean.....	Apr. 20, 1916	B-2131	3,002.50	1,802	2,421	2,905.20
Lewisiam.....	British.....	May 23, 1916	B-2250	2,231.25	1,785	2,213	2,655.60
Limari.....	Chilean.....	May 31, 1916	B-2280	2,002.50	1,602	2,421	2,905.20
Lompoc.....	British.....	June 10, 1916	B-2357	3,846.24	3,400	3,342	3,846.24
Lord Derby.....	do.....	June 20, 1916	B-2357	3,001.25	2,401	3,588	4,305.60
Mantaro.....	Peruvian.....	May 3, 1916	C-2969	1,307.60	2,594	2,673	3,207.60
Manavi.....	do.....	May 5, 1916	C-2977	722.50	578	745	894.00
Melania.....	do.....	May 17, 1916	C-3065	1,311.60	3,594	4,330	3,117.60
Mantaro.....	Peruvian.....	June 2, 1916	C-3184	1,307.60	2,594	2,673	3,207.60
Mantaro.....	Chilean.....	June 4, 1916	C-3200	1,548.40	4,628	4,572	5,486.40
Maipo.....	British.....	June 12, 1916	C-3256	1,536.40	3,578	745	536.40
Manavi.....	do.....	Mar. 17, 1916	B-2027	1,56.40	48	47	56.40
Mana (yacht).....	Peruvian.....	Apr. 26, 1916	B-2152	1,307.60	2,501	2,073	3,207.60
Mantaro.....	British.....	Apr. 27, 1916	B-2186	2,797.50	578	745	894.00
Mary Park.....	do.....	May 15, 1916	B-2224	2,787.50	2,500	2,872	3,446.40
Minerva.....	Dutch.....	May 17, 1916	B-2294	2,152.50	1,802	1,974	2,368.80

	British.	May 26, 1916	722.50	578	745
Manavi.....	British.....	May 26, 1916	1 3,207.60	2,594	804.00
Manitara.....	Peruvian.....	June 8, 1916	5,136.25	4,100	3,207.60
Minnesotan.....	American.....	June 8, 1916	4,456.25	3,565	5,712.00
Nadica.....	British.....	May 2, 1916	1,960.68	2,003	5,217.60
Nissei Maru.....	Japanese.....	May 11, 1916	2,067.50	1,654	1,669.68
Newport.....	American.....	June 24, 1916	1,693.68	2,003	2,505.60
Nissei Maru.....	Japanese.....	June 30, 1916	2,134.80	1,967	1,669.68
Navajo.....	American.....	Dec. 18, 1915	3,985.00	2,188	2,134.80
Nissei Maru.....	Japanese.....	Dec. 23, 1915	2,503.75	2,003	2,294.80
Do.....	do.....	Apr. 17, 1916	2,503.75	2,003	4,294.80
Newport.....	American.....	June 9, 1916	2,067.50	1,654	2,782.80
Oyletic.....	British.....	June 17, 1916	3,194.64	3,791	2,995.60
Ormlston.....	do.....	Apr. 10, 1916	2,067.50	1,654	3,194.64
Orarl.....	American.....	Apr. 24, 1916	2,067.50	1,654	4,922.40
Ohioan.....	do.....	Apr. 30, 1916	2,067.50	1,654	8,998.80
Oak Branch.....	American.....	May 17, 1916	5,126.25	4,101	6,079.20
Otaki.....	British.....	June 6, 1916	3,063.75	3,791	1,359.45
Oyletic.....	do.....	May 31, 1916	4,738.75	3,791	5,271.60
Otaki.....	do.....	May 31, 1916	3,945.00	6,115	8,338.80
Ormlston.....	do.....	June 28, 1916	3,945.00	6,115	4,969.20
Ocean Monarch.....	do.....	June 30, 1916	3,081.25	2,945	4,136.40
Panga No. 1333.....	do.....	Mar. 17, 1916	1 1.20	1	1.20
Pacific.....	do.....	May 13, 1916	3,296.25	2,637	4,647.60
Peru.....	do.....	do.....	2,100.00	1,680	3,151.20
Port Hardy.....	do.....	May 19, 1916	5,298.75	4,239	7,041.60
Palatia.....	do.....	May 26, 1916	2,815.00	2,252	3,080.40
Potosi.....	do.....	May 29, 1916	4,082.50	3,226	5,209.20
Palena.....	Chilean.....	May 31, 1916	2,055.00	1,644	2,537
Paparoa.....	British.....	June 2, 1916	2,055.00	1,644	3,044.40
Peru.....	American.....	June 3, 1916	2,688.75	2,135	2,929.20
Penrith Castle.....	British.....	June 10, 1916	3,478.75	3,892	6,993.60
Paraiso.....	American.....	June 21, 1916	2,688.75	2,135	3,985.20
Peru.....	do.....	June 7, 1916	1,671.76	933	3,671.76
Palena.....	Chilean.....	May 24, 1916	2,100.00	1,680	3,151.20
Peru.....	American.....	May 29, 1916	2,688.75	2,135	3,044.40
Paraiso.....	do.....	June 16, 1916	1,115.00	892	2,929.20
Peru.....	do.....	June 27, 1916	2,100.00	1,680	2,400.80
Quilpuce.....	do.....	June 3, 1916	2,506.25	2,005	3,151.20
Do.....	do.....	May 26, 1916	2,506.25	2,005	2,677.20
Ranella.....	do.....	Apr. 29, 1916	4,498.75	3,543	5,109.60
Ribera.....	do.....	June 25, 1916	2,766.25	2,213	3,138.40
Riverforth.....	Dutch.....	Apr. 19, 1916	5,952.50	4,762	6,458.40
Raicaigua.....	British.....	May 13, 1916	3,603.75	2,883	4,376.40
Raicaigua.....	Chilean.....	June 21, 1916	1,869.60	3,093	4,869.60
Santki Maru.....	Japanese.....	Apr. 18, 1916	1,553.75	3,043	5,043.00
San Juan.....	American.....	Apr. 21, 1916	1,636.25	1,309	1,893.00
Solano.....	do.....	Apr. 20, 1916	636.25	323	581
Suruga.....	do.....	Apr. 20, 1916	3,423.75	2,739	6,071.20
Strathesk.....	British.....	May 1, 1916	12,566.80	32,806	2,966.80
Someset.....	American.....	do.....	3,903.00	3,121	4,720.80

\* Ballast.

1 Panama Canal.

2 Panama Canal tonnage, including deck load.

TABLE No. 67A.—Statement of tolls collected Sept. 18, 1915, to June 30, 1916—Continued.

Vessel.	Nationality.	Date.	Bill No.	Tolls collected.	Panama Canal rules.	
					United States registered tonnage.	Tonnage. Amount.
Stipton Castle.....	British.....	May 8, 1916	C-2998	\$3,053.75	2,443	\$4,258.80
Salvador.....	do.....	May 31, 1916	C-3159	830.40	706	830.40
Shinko Maru.....	Japanese.....	June 2, 1916	C-3178	2,443.75	1,955	2,598.00
Standard Oil Barge No. 93.....	American.....	June 5, 1916	C-3214	1,580.40	3,187	1,580.40
San Jose.....	do.....	June 9, 1916	C-3237	1,648.75	1,319	1,617
Strathcarron.....	British.....	June 16, 1916	C-3271	2,476.08	3,439	2,476.08
Stella.....	Dutch.....	June 24, 1916	C-3322	2,280.00	1,808	2,300.40
Sorata.....	British.....	June 25, 1916	C-3332	3,733.75	2,987	4,015.20
Salvador.....	do.....	June 29, 1916	C-3351	1,830.40	706	830.40
Sherman.....	American.....	June 30, 1916	C-3393	3,726.25	2,981	3,512
Saint Andrew.....	British.....	do.....	C-3395	3,831.25	3,065	4,695.20
Sullana.....	American.....	Dec. 18, 1915	B-1858	1,256.80	212	256.80
San Diego.....	do.....	do.....	B-1859	1,970.80	805	970.80
Saint Veronica.....	British.....	Apr. 14, 1916	B-2076	3,775.00	3,020	5,064.00
Sommerstad.....	Norwegian.....	Apr. 13, 1916	B-2081	3,142.50	2,514	3,812.40
San Juan.....	American.....	Apr. 17, 1916	B-2116	1,686.25	1,309	1,893.60
Santa Clara.....	do.....	Apr. 22, 1916	B-2124	5,131.25	4,121	5,428.80
Selandia.....	Danish.....	Apr. 17, 1916	B-2126	4,032.50	3,242	4,000
Solano.....	American.....	do.....	B-2127	666.25	525	1,002.00
Spithead.....	British.....	Apr. 24, 1916	B-2142	3,741.25	2,933	4,428.20
Strathfillan.....	do.....	Apr. 25, 1916	B-2146	3,520.00	2,816	4,038.40
Sahara.....	do.....	Apr. 27, 1916	B-2155	3,331.25	2,665	4,020.00
Standard Oil Barge No. 93.....	American.....	Apr. 29, 1916	B-2161	2,321.25	1,857	2,634.00
San Francisco.....	Swedish.....	May 1, 1916	B-2171	2,956.25	2,365	4,801.20
San Ramon.....	American.....	May 15, 1916	B-2216	758.75	607	738
Salvador.....	British.....	May 26, 1916	B-2233	1,830.40	706	830.40
San Jose.....	do.....	do.....	B-2292	1,648.75	1,319	1,617
Standard Oil Barge No. 93.....	British.....	June 3, 1916	B-2306	2,321.25	1,857	2,634.00
Strathesk.....	American.....	June 6, 1916	B-2306	3,502.50	2,802	3,565
Santa Catalina.....	do.....	June 22, 1916	B-2308	4,822.50	3,858	5,290.80
Salvador.....	do.....	June 26, 1916	B-2380	1,636.25	1,309	1,578
San Juan.....	British.....	do.....	B-2381	1,830.40	706	830.40
Tenryu Maru.....	Japanese.....	Apr. 15, 1916	C-2850	2,006.25	1,605	1,788
Towa Maru.....	do.....	May 1, 1916	C-2159	2,232.50	1,786	2,414.40
Thode Fagelund.....	Norwegian.....	May 5, 1916	C-2180	2,581.92	3,286	2,581.92
Turret Crown.....	British.....	May 21, 1916	C-3099	1,570.00	1,256	1,597.20
Terrier.....	Norwegian.....	do.....	C-3104	2,903.04	3,235	4,032
Tongking.....	Danish.....	June 2, 1916	C-3185	4,240.00	3,392	5,358
Toyohashi.....	Japanese.....	June 10, 1916	C-3241	5,492.50	4,394	6,429.60
Tuscan Prince.....	British.....	June 18, 1916	C-3256	4,146.25	3,317	5,709
Thode Fagelund.....	Norwegian.....	Apr. 16, 1916	B-2098	3,532.50	2,826	6,186.00
Terrier.....	do.....	Apr. 26, 1916	B-2147	4,020.00	3,216	4,338.40

Tricolor.....	do.....	May 22, 1916	B-2248	3,256.25	2,605	3,360	4,032.00
Tricolor Pagelund.....	do.....	June 2, 1916	B-2291	3,532.50	3,586	4,303.20	
Torrier.....	do.....	June 19, 1916	B-2354	4,043.75	3,235	4,838.40	
Urubamba.....	Peruvian.....	Apr. 27, 1916	C-2323	3,171.25	2,537	3,118	3,741.60
Ucayali.....	do.....	May 9, 1916	C-3000	1,550.00	1,240	2,206	2,647.20
Urubamba.....	do.....	May 24, 1916	C-3112	3,171.25	2,537	3,118	3,741.60
Ucayali.....	do.....	June 6, 1916	C-3217	1,550.00	1,240	2,206	2,647.20
Urubamba.....	do.....	Apr. 29, 1916	B-2153	3,171.25	2,537	3,118	3,741.60
Ucayali.....	do.....	May 8, 1916	B-2153	1,550.00	1,240	2,206	2,647.20
Urubamba.....	do.....	May 18, 1916	B-2278	3,171.25	2,537	3,118	3,741.60
Ucayali.....	do.....	May 31, 1916	B-2279	1,550.00	1,240	2,206	2,647.20
Urubamba.....	do.....	June 23, 1916	B-2377	3,171.25	2,537	3,118	3,741.60
Ucayali.....	do.....	June 25, 1916	B-2385	1,550.00	1,240	2,206	2,647.20
Victoria.....	Dutch.....	May 5, 1916	C-2383	1,603.60	3,659	5,083	6,103.60
Veendijk.....	British.....	June 4, 1916	C-3201	4,443.75	2,184	4,566	5,479.20
Vine Branch.....	do.....	June 12, 1916	C-3257	2,730.00	2,184	3,016.80	
Valdivia.....	Chilean.....	June 10, 1916	B-2322	1,797.50	1,438	1,935.60	
White Wing.....	American.....	Jan. 4, 1916	C-2575	13.60	3	3.60	
Wisdom.....	do.....	Mar. 30, 1916	C-2797	139.60	32	39.60	
Windber.....	do.....	Apr. 10, 1916	C-2833	2,520.00	2,093	2,100	2,520.00
Wubana.....	British.....	May 5, 1916	C-2979	2,438.64	3,819	3,387	2,438.64
Wastmeath.....	do.....	May 7, 1916	C-2990	6,521.25	5,217	6,850	8,220.00
Wakasa Maru.....	Japanese.....	May 9, 1916	C-2996	4,668.75	3,735	4,256	5,083.20
Whakatane.....	British.....	May 15, 1916	C-3049	4,617.50	3,694	5,544	6,652.80
Warren.....	do.....	Apr. 18, 1916	B-2121	2,962.50	2,370	3,066	3,679.20
Wabana.....	do.....	June 4, 1916	B-2297	3,523.75	2,819	3,387	4,064.40
Wm. H. Murphy.....	American.....	June 9, 1916	B-2304	505.50	674	637	473.04
York Moor.....	British.....	June 26, 1916	C-3338	3,403.75	2,723	4,105	4,926.00

<sup>2</sup> Panama Canal tonnage, including deck load.<sup>1</sup> Panama Canal.<sup>3</sup> Ballast.





## APPENDIX I.

### REPORT OF THE EXECUTIVE SECRETARY, EXECUTIVE DEPARTMENT.

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BALBOA HEIGHTS, CANAL ZONE, *August 12, 1916.*

SIR: I submit herewith a report covering the work of the executive department during the fiscal year 1916. This includes a statement of the business transacted by the courts of the Canal Zone, which for administrative purposes only are considered in the executive department.

#### ORGANIZATION.

The organization of the executive department was continued along the lines indicated in the reports for 1914 and 1915.

#### EXECUTIVE OFFICE.

The routine work of the executive office, conducted through the correspondence, personnel, record, timekeeping, property, and requisition, and general bureaus was carried on along the lines heretofore outlined. The work of the bureau of clubs and playgrounds was also conducted under the executive office.

#### BUREAU OF CLUBS AND PLAYGROUNDS.

Clubhouses for gold employees were operated at Cristobal, Gatun, Pedro Miguel, Corozal, Ancon, and Balboa, and for silver employees at Gatun and La Boca. The clubhouse for gold employees at Ancon, composed of the old district quartermaster's office and an extensive addition, was erected at a cost of \$21,863, derived from clubhouse funds collected since 1907. It was opened on April 8. The clubhouse at Corozal was closed on November 15 and was taken over by the Army authorities. At Paraiso the lodge hall was used one evening a week to show moving pictures. The clubhouse of the Balboa yacht club was opened on May 29. The tarpon club, organized for fishing at Gatun Spillway, constructed a clubhouse at the Spillway from funds collected from memberships. A golf club was organized at Gatun and links were laid out on the slope of the dam between Gatun Locks and the Spillway.

At Balboa an outdoor swimming pool 65 by 125 feet and from 3 to 12 feet deep was constructed adjacent to the clubhouse. It is supplied with salt water pumped direct from below tide level.

Playgrounds have been set aside in Cristobal for immediate development and in Cristobal and Ancon for later development.

In addition to their ordinary functions the clubhouses presented lyceum entertainments and local dramatic and musical entertainments. An independent film service was maintained with a run of 140,000 feet of moving pictures weekly. Dances were held biweekly under the auspices of the clubhouses and the dance floors have been used by various social and fraternal organizations.

The clubhouses continue as the centers of organized social movements, such as musical clubs, Boy Scouts, Camp Fire Girls, athletic clubs, chess clubs, and other organizations of employees.

In clubhouses having assistant secretaries acting as physical directors, gymnasium activities continued popular, the largest classes being those for women, the enrollment at the Balboa clubhouse exceeding 70 women. Calisthenic drills for school children at Ancon and Balboa schools were continued during the past year by the physical director of the Balboa clubhouse. At Balboa during the dry season afternoon baseball was promoted by the twilight and sunset leagues, playing from shortly after 4 until dusk at 6.30 p. m. The Governor's pennant in the Panama Canal baseball league was won by the Balboa team.

In towns in which the Union Church did not make use of the clubhouses for an evening church service, the clubhouses conducted a community Sunday evening service of song. Bible classes were also conducted in four of the clubhouses.

In the absence of an official celebration of the Fourth of July in 1915, the Balboa clubhouse promoted a community celebration in which all of the towns on the Isthmus joined. The cost of the celebration, which was over \$1,100, was defrayed by subscription among the residents of Balboa and Ancon.

During the year the sum of \$27,519.03 was expended in permanent improvements on playgrounds and buildings. The following is a statement of the net receipts and expenditures resulting from clubhouse operations, and included the investments in playgrounds and improvements:

Balance on hand July 1, 1915.....		\$21,339.50
Net receipts:		
Membership.....	\$10,173.22	
Soda fountain.....	10,931.44	
Billiards and pocket billiards.....	2,262.22	
Motion pictures.....	114.32	
Pressing club.....	125.43	
Cigars and candy.....	7,006.56	
Rentals.....	437.20	
Tennis club.....	135.82	
Playgrounds.....	100.03	
Brake service.....	401.02	
Fishing tackle.....	36.47	
Swimming tank.....	15.76	
		<u>31,739.49</u>
		53,078.99
Net expenditures:		
Bowling alleys.....	256.05	
Entertainments.....	2,512.72	
Office help.....	4,612.94	
Library books and periodicals.....	1,097.56	
Maintenance and general expenses.....	5,961.81	
Supplies and equipment.....	1,843.64	
Salable merchandise.....	483.14	
Activities.....	761.20	
Tournaments.....	317.17	
Gun club.....	175.03	
Golf club.....	700.00	
Golf club--salable merchandise.....	205.44	
Baseball grounds.....	170.63	
New buildings.....	21,863.47	
Balboa yacht club.....	4,321.63	
		<u>45,282.43</u>
Balance on hand June 30, 1916.....		7,796.56
Estimated liabilities June 30, 1916.....		8,587.72
Deficit.....		<u>719.16</u>

The total expenses paid by the Government for salaries of secretaries and janitors, upkeep of buildings, furniture, etc., are \$48,291.36, as compared with \$42,568.16 last year.

#### DIVISION OF CIVIL AFFAIRS.

The work of the customs, posts, local licensing, administration of estates of deceased employees, shipping commissioner, and publication of the weekly bulletin, the Canal Record, was carried on by this division, and details will be found in Tables Nos. 1 to 15 accompanying this report.

#### SHIPPING COMMISSIONER.

The duties of shipping commissioner have been delegated to this division and it has exercised practically the same powers as are exercised by American consuls in foreign ports. This power has been questioned and Congress was requested to enact legislation making it definite, and the following provision was enacted in H. R. 15955, which was passed by the House of Representatives on June 17:

The laws relating to seamen of vessels of the United States on foreign voyages shall apply to seamen of all vessels of the United States at the Panama Canal Zone, whether such vessels be registered or enrolled and licensed, and the powers in respect of such seamen of such vessels bestowed by law upon consular officers of the United States in foreign ports and upon shipping commissioners in ports of the United States are hereby bestowed upon the shipping commissioner and deputy shipping commissioners of the Panama Canal Zone.

In the same connection the diplomatic and consular appropriation act which became law on July 1 included the Panama Canal Zone in the countries to which relief and protection of American seamen may be extended.

#### CUSTOMS.

On September 1, 1915, the Government of Panama was notified that the existing Chinese exclusion laws should not be held to apply to Chinese crews of vessels. Customs officers were directed to continue checking the Chinese crews, but to make no further effort to prevent them from coming ashore in the Canal Zone.

Section 10 of the Panama Canal act which confers authority upon the Governor to prohibit any person from remaining on or passing over any part of the Canal Zone, and to require a ship bringing an undesirable to the Canal Zone to return him to the place of origin, will not become operative until the canal is officially declared open. Legislation has been requested therefore to confer this power upon the Governor pending operation of this section of the Panama Canal act.

During the year 395 prohibited aliens arrived at Balboa and 158 at Cristobal in transit to the Republic of Panama and other countries. By authority of Panamanian officials 343 were allowed to disembark, 1 escaped, 3 were transferred to their vessels or returned to the port of embarkation, and 206 were transferred passengers. These figures apply to passengers only, and not to members of crews.

The customs bureau and police division are in possession of information indicating that large quantities of opium are smuggled through the Canal Zone into the Republic of Panama and that a considerable portion is later smuggled into the United States. This is a most pernicious traffic, and both the customs bureau and the police division have made every effort within their power to break it up. This traffic is so profitable that it can only be broken up by assessing heavy fines and giving long prison sentences. The penalty for smuggling opium is a maximum fine of \$5,000 and a minimum fine of \$50 and imprisonment not exceeding two years, or both such fine and imprisonment. During the year there were 35 arrests of persons on this charge, of whom 6 were acquitted. In the majority of cases the minimum fine only was assessed. The greatest fine assessed any individual was \$100, and the greatest fine assessed against a ship was \$190. It will be a hard problem to cope with until heavier penalties are inflicted.

In spite of the fact that the canal was closed several months of the fiscal year, it will be noted from Table No. 1 that there has been practically no decrease in shipping at Balboa and Cristobal. The total number of vessels entered was 2,130 and the total number of vessels cleared 2,123, as compared with 2,135 entered and 2,125 cleared during the previous fiscal year. There were 2,631 seamen shipped on American vessels and 2,475 seamen discharged, as compared with 1,033 shipped and 941 discharged during the preceding year. The greatly increased work has been performed by the same force as in June, 1915, consisting of two chief customs inspectors, seven customs inspectors, and one messenger. The estimates for the fiscal year ending June 30, 1917, call for an addition of three inspectors.

#### LICENSES AND TAXES.

Motor vehicle and bicycle licenses are issued by the division of civil affairs, as well as licenses for hunting and carrying firearms and permits for the peddling of foodstuffs. During the fiscal year 1916 there were 2,569 such licenses and permits issued, of which 1,078 were for motor vehicles. Motor-vehicle license fees in the Canal Zone have always been considered excessive, and an attempt has been made to have them reduced. In a bill passed by the House of Representatives on June 17, 1916 (H. R. 15955), the President is given power, among other things, to make rules for regulating licenses and taxing the use or operation of all self-propelled vehicles using public highways in the Canal Zone. If this bill becomes a law it is proposed to reduce motor-vehicle license fees.

#### CANAL RECORD.

The Canal Record was continued during the year as a weekly paper devoted to the publication of shipping news, statistics of traffic, executive orders, official advertisements, notices, and circulars. Inquiries have been addressed to a great many shipping interests asking for suggestions as to any method of making statistics of traffic more complete. It is intended that these statistics should cover as broad a scope as possible.

It is found necessary to continue the Canal Record as an 8-page quarto, but the cost of publication was reduced from \$13,585.15 in 1915 to \$10,806.28 in 1916. Collections on account of subscriptions and the sale of extra copies and bound forms amounted to \$561.50.

#### POSTAL SERVICE.

Attention is invited to the statement of postal receipts and expenditures which is appended to this report. It will be noted that the receipts for 1916 were \$1,060.90 more than in the previous year. The expenses were \$9,739.19 less. The deficit was \$44,527.14, as compared with \$55,327.23 in 1915. In any consideration of the postal deficit it should be remembered that the postal service is still burdened with a subsidy to the Panama Government equivalent to 40 per cent of its total stamp sales—in 1916, \$27,207.86—and that the service is allowed no credit in the accounts for the interest earned by money-order and postal-savings funds on deposit with banks, amounting in 1916, according to an estimate furnished by the auditor, to about \$39,000. If the subsidy were withdrawn and the credit were allowed for interest earned by these funds, the account would show a surplus of approximately \$20,000.

Deposit money orders issued during the year had a total value of \$1,101,190, and payments of deposit money orders during the same period aggregated \$1,103,340, leaving a balance on deposit on June 30, 1916, of \$350,650. When deposit money orders were substituted for the postal-savings system in the Canal Zone it was decided that postal-savings certificates would be paid only as they were called for by the depositors. On July 1, 1915, there were still open 348 of the original postal-savings accounts, represented by unpaid certificates for \$124,661. The certificates paid during the fiscal year 1916 totaled \$110,360, leaving on June 30, 1916, accounts aggregating \$14,301. All these open postal-savings accounts were turned in to the accounting department on June 30, 1916, and will be paid direct by that department on request instead of being handled by post offices. The total amount deposited with post offices on June 30, 1916, was, therefore, \$377,-617.80.

As previously stated in this report, a large part of the deficit of the Canal Zone postal system would be wiped out if the postal division were allowed interest received from Canal Zone money-order funds deposited in banks under Canal Zone regulations. In the past these earnings have been deposited with the United States Treasurer. If this interest were credited to the postal division, it would also permit the payment of interest upon deposit money orders. The following sections were therefore made a part of a bill which passed the House of Representatives on June 17, 1916 (H. R. 15955):

SEC. 7. That deposit money orders issued in the Canal Zone in lieu of postal-savings certificates in accordance with the rules and regulations heretofore established by the President, or that may hereafter be established by him, shall bear interest at a rate not exceeding two per centum per annum.

SEC. 8. That the interest received from the Canal Zone money-order funds deposited in banks under Canal Zone regulations shall be available to pay the interest on deposit money orders authorized by the preceding section. Such interest shall also be available to pay any losses which are chargeable to the Canal Zone postal service.

It is hoped that this legislation will be enacted.

Mail addressed to ships transiting the canal is sent to the office of the captain of the port at which the ship is due to arrive first, and is delivered on board the ship by the boarding officer of the customs service, who is also prepared to sell stamps, accept letters for registry, as well as ordinary mail, and furnish applications for both domestic and international money orders, taking the money from the remitter and issuing a receipt for the same.

At present the service is confronted with the serious problem of the rifling of registered mail dispatched to the different islands of the West Indies, and this matter has become so serious that it has become necessary to forward all such mail through the New York, N. Y., exchange post office. This causes considerable delay, but is necessary in order to insure the safe dispatch of this mail. This matter is still under investigation, and representations are being made to the postal services of France and the West Indies in connection therewith. It has been established that the rifling did not take place in the Canal Zone, as the dispatches were witnessed at the Cristobal exchange post office by either the postmaster or the post-office inspector. The assistance of the American consuls at the different West Indian ports has been enlisted, and it is hoped that this investigation will be completed and the matter satisfactorily adjusted. There are at present under investigation 33 cases of the rifling of registered mail, pertaining principally to mail dispatched to the West Indies.

In June, 1915, the limit of weight of mail matter of the third and fourth classes was raised from 11 pounds to 20 pounds to conform with the parcel-post weights in effect in the United States.

#### POLICE AND FIRE DIVISION.

Detailed statements of work of the police and fire forces and of the penal work of The Panama Canal will be found in Tables Nos. 16 to 59 accompanying this report.

#### POLICE SECTION.

Contrary to expectation necessary police work did not diminish during the year 1916, and it was found that the appropriations for the year were inadequate. Changes were made, however, which resulted in the discharge of 23 second-class, or colored, policemen and the reduction of pay of 42 first-class, or American, policemen and 13 second class. The colored policemen on the Panama Railroad wharves at Cristobal and Balboa were replaced on July 1 by 23 white policemen. When the work of cargo handling fell off upon the reopening of the canal the force on the wharves was reduced to 16 first class and 6 second class policemen.

For military reasons the force of policemen on the locks was increased by 41 first-class officers on April 20, and these men were recruited from the military force on the Isthmus. A patrol launch was operated at the Pacific entrance of the canal to prevent smuggling and irregular trading, one at the entrance of Gaillard Cut at Gamboa, and one in Gatun Lake, making regular inspection trips and assisting in the work of depopulating the Canal Zone.

The course of target practice was continued, 150 policemen taking part.

Continuous guard duty was performed by policemen at Pedro Miguel and Miraflores Locks and three plain clothes men were stationed at Gatun Locks which are guarded by military forces.

A census of all habitations and cultivations remaining in the Canal Zone was made during November and monthly inspection thereafter assisted in keeping new cultivations or settlements from being made. Notice was served upon all persons residing or having cultivations within the 80 and 100 feet contour lines of Gatun Lake that they would not be allowed to make new cultivations after 1915. A complete census of the Canal Zone was made during the month of June and the results are found in Table No. 59 accompanying this report.

#### FIRE SECTION.

The fire force remained the same as at the close of the last fiscal year. The work of the department is classified in Tables 43 to 59 of this report. The only important fire occurring in the Canal Zone was that in the steamship *Antonio Lopez*, at Cristobal, which was extinguished after a loss of \$20,000.

#### CRIMES AND PENOLOGY.

Tables Nos. 21 to 30 accompanying this report give data of crimes and criminals in the Canal Zone during the fiscal year. Four thousand four hundred and eighty persons were arrested, of whom 274 were females; 4,167 were given court trials, and 3,389 were convicted, 767 were discharged, and 11 were awaiting trial at the close of the year. Of the remaining 313 arrested and held in custody 4 were sent to the asylum for the insane, 64 were turned over to the military authorities, 43 to the quarantine authorities, 27 to the Panamanian Government, 3 were extradited, 8 forfeited their bail by failing to appear for trial, 97 were deported, and 66 were returned to merchant vessels.

Five homicides were committed. One offender, a woman, was acquitted, one was sentenced to one year and six months in the penitentiary, one to 20 years in the penitentiary, and two were awaiting trial at the close of the year.

In cooperation with the customs officers, special effort was made to break up the traffic in smuggling opium across the Isthmus. Thirty-five persons were arrested, of whom 29 were convicted and 6 dismissed. Charges were filed also against three vessels; fines were imposed against two and one was dismissed. Fines amounting to \$2,290 were imposed.

Ninety-seven persons were deported from the Canal Zone, of whom 53 were convicts who had completed terms of imprisonment, and the balance were persons convicted of misdemeanors who were deemed undesirable.

Fifty-nine convicts were received at the penitentiary, a decrease of seven compared with the previous year. The aggregate sentences imposed amounted to 64 years and 9 months. Sixty-six completed

terms and were discharged and all not residents here prior to May 4, 1904, were deported. "Good time" credits amounting to 7 years, 5 months, and 26½ days were earned. At the close of the year 51 remained in custody.

Prisoners were employed on the construction of the new road roughly paralleling the canal on the east side, an extension of the highway from Panama to Gamboa, and 5  $\frac{1}{4}$  miles were completed. Other prisoners were employed to keep up the penitentiary buildings and grounds, and to do necessary inside work. The labor performed on road work was valued at \$10,256.60, at the rate of 10 cents per hour, and the value of labor performed inside of the prison, other than for maintenance, amounted to \$148.10.

The cost of subsisting and guarding the convicts was \$18,525.32, \$4,935.21 of which was expended for subsistence for convicts, \$1,356.32 for subsistence of guards, \$7,173.32 for salaries of officers and guards at the penitentiary, and \$5,061.03 for salaries of officers and guards on road work.

Three convicts were pardoned during the year, and sentence was remitted in the case of one convict by the Governor for special reasons.

#### DIVISION OF SCHOOLS.

Work in the grades for white and colored children, and in the high school and industrial courses, for white children only, was carried on from October 4, 1915, to June 30, 1916, with a vacation of two days at Thanksgiving time, two weeks at Christmas, and one week at Easter. Date of enrollment, attendance, physical condition, teaching force, and money receipts will be found in Tables Nos. 60 to 72 accompanying this report.

Effective July 1, 1916, the following schedule of salaries for teachers went into effect. It is based upon salaries paid to school teachers in the District of Columbia, with an increase that brings the rate within the 25 per cent limit allowed by the law:

	Entrance salary.	Second year.	Third year.	Fourth year and after.
Elementary teachers <sup>1</sup> .....	\$95	\$100	\$105	\$110 per month for 9 months.
High-school teachers.....	120	125	130	\$135 per month for 9 months.
Science teachers.....	145	150	155	\$160 per month for 9 months (man).
High-school principal.....	165	170	175	\$180 per month for 9 months.
Supervisor of lower grades....	175	180	185	\$190 per month for 10 months.
Supervisor industrial training	200	200	200	\$200 per month for 12 months.
Brake attendant.....	30	30	30	\$30 per month for 9 months.

<sup>1</sup> Includes teacher of Spanish in grades.

*Principals (in addition to regular salaries as teachers).*

Per month  
for 9 months.

Two-room buildings.....	\$10
Three to 5-room buildings.....	15
Six to 8-room buildings.....	20
Nine to 12-room buildings.....	30
Buildings with more than 12 rooms.....	40

*Line teachers.*—Equivalent to principal of three to five room building, \$15 for 9 months.



*Colored teachers.*Per month  
for 9 months.

Teachers.....	\$60
Principals of two-room buildings.....	15
Principals of three to six-room buildings.....	10

In addition to salary as teacher.

A revised course of study for the elementary schools went into effect October 1, 1915, and the high-school course will be revised during the present vacation, to become effective at the beginning of school in October.

## SCHOOLS FOR WHITE CHILDREN.

Schools for white children were conducted as follows: Empire, first six grades; Paraiso, first three grades; Pedro Miguel, first seven grades; Colon Beach, first four grades; Cristobal, eight grades and two years in high school; Ancon and Gatun, eight grades; Balboa, eight grades and four years in high school. Children living in villages where the schools did not offer the work for which they were fitted were furnished transportation to the nearest school offering proper facilities. The school at Corozal was closed on November 19, 1915, and the children of officers and enlisted men of the Army quartered there were furnished transportation to attend the school at Balboa.

Physical examinations of pupils in the grade schools were made in October, and the results of these are given in Table No. 69.

Physical training was continued under the direction of the physical directors of the various clubhouses. A high-school track and field meet was held at Pedro Miguel May 13, 1916; high school aquatic meet at Balboa on May 20, and grammar-school track and field meet at Balboa on May 27, 1916.

The study of Spanish was extended to include the third grades.

A four-year commercial course was added to the high-school work at the beginning of the school year and 45 pupils were enrolled. The subjects taught are bookkeeping, business law, commercial geography, commercial history, spelling, writing, commercial correspondence, business arithmetic, typewriting, and the Gregg system of shorthand.

## INDUSTRIAL TRAINING AND APPRENTICESHIP.

A two months' vacation course of woodwork and shop drawing at the Balboa workshop was offered to boys who would be in the seventh and eighth grades or the high school at the opening of the school year in October. The work was begun on July 21 and was carried on from 9 to 11 a. m. and from 2 to 4 p. m. on Monday, Wednesday and Friday of each week. Thirty-three boys took the course.

In the regular school terms the industrial courses in the high school were taken as follows: Elementary mechanical drawing, 12 boys; advanced mechanical drawing, 6 boys; elementary woodwork, 23 boys; advanced cabinetmaking, 2 boys.

In the seventh and eighth grades at Balboa and Ancon 57 boys took courses in shopwork, and while they were in the work shop the girls of these grades were given lessons in sewing by their respective teachers. Hand sewing, the study of stitches, the drafting of patterns, and the study of textiles and weaves made up the sewing course.

The boys apprenticed at various trades in Balboa shops were given a course of instruction on Tuesday and Saturday afternoon of each

week at the Balboa high school, and their progress was more satisfactory than heretofore. The number of boys apprenticed to each trade is as follows:

Machinists.....	15
Boilermakers.....	6
Pipefitters.....	3
Plumbers.....	1
Blacksmiths.....	2
Shipwrights.....	1
Molders.....	1
Patternmakers.....	1
Car repairers.....	1
Coppersmiths.....	1
Total.....	32

In furtherance of the plan to keep the boys of the school busy during vacation time 15 upper grade and high school boys were employed in the various commissaries during the vacation months of 1915.

#### SCHOOLS FOR COLORED CHILDREN.

Alien employees of the canal and the Panama Railroad residing outside the Canal Zone had, prior to this school year, been allowed tuition to the schools free of charge. This privilege was withdrawn at the beginning of the year, with the result that four rooms in the Cristobal school for colored children, and the entire Ancon school, consisting of four rooms, were closed, and the force of teachers for the colored schools was reduced by seven.

The eight grades were taught at La Boca and Paraiso, and the first six at Empire, Gatun, and Cristobal. At Cristobal, Gatun, Paraiso, and Empire it was necessary to adopt the double-session plan in order to accommodate the teaching force and the school space to the large number of pupils. One section attended from 7.30 to 10 a. m. and from 12.30 to 2.30 p. m., and the other from 10 a. m. to 12.30 p. m. and from 2.30 to 5 p. m.

#### BUILDINGS AND GROUNDS.

Sixteen buildings were used for school purposes, 11 for white children and 5 for colored children. At Cristobal, on account of the noise caused by the construction of a new building, it was necessary to abandon the building occupied as a school for white children and to move the white school to the building occupied by the colored school. The colored school was removed to the lodge hall.

Sites for concrete buildings for white schools have been selected for Balboa, Ancon, Pedro Miguel, Gatun, and Colon Beach. The plans are in preparation, and it is expected that all the new buildings will be ready for occupancy by the time school opens in October, 1917.

#### THE COURTS.

In the district court 89 cases were pending at the beginning of the year, 789 cases were filed and 752 decided, leaving 126 cases pending on June 30, 1916. Of the cases decided 91 were civil, 284 probate, and 377 criminal. Court was held both at Ancon, for the Balboa division, and at Cristobal. There were 117 sessions of court. There

were 581 marriage licenses issued by the clerk of the court and 136 deeds recorded. The sum of \$4,761.80 was collected in fines, costs, and fees.

In the magistrate's court for the Balboa subdivision 4 cases were pending at the beginning of the year, 2,233 cases were docketed, and 2,136 cases were settled, leaving 101 cases pending at the close of the year. Of the cases docketed 96 were civil and 2,137 criminal. Of the criminal cases 50 were dismissed, 233 were committed to the district court, and there were 1,606 convictions and 247 acquittals. Collections on account of fines and fees amounted to \$5,995.50.

In the magistrate's court for the Cristobal subdivision 5 cases were pending at the beginning of the fiscal year, 2,403 cases were docketed during the year, of which 125 were civil and 2,278 criminal cases, leaving 122 cases pending at the close of the year. The criminal cases resulted in 1,659 convictions, 410 acquittals, 60 dismissals, and 157 cases were committed to the district court. A total of \$6,053.53 was collected in fees and fines.

#### SPECIAL ATTORNEY AND DISTRICT ATTORNEY.

The reports of the special attorney and of the district attorney are printed as appendices to the Governor's report.

#### RELATIONS WITH PANAMA.

Negotiations by correspondence or personal conference between the executive secretary and the secretary for foreign affairs of the Republic of Panama included, among others, the following subjects in addition to routine matters:

Exemption of contract laborers of The Panama Canal and the Panama Railroad, and their families, from payment of a deposit of \$30 required of each deck passenger arriving at any port in the Republic of Panama by Panama immigration law No. 32, of 1914.

Construction of a warehouse in Panama City to be used as a receiving depot for all fruits and vegetables of local production which may be offered for sale.

Erection of a monument in honor of the Panama fire brigade in the park opposite the railroad station in the City of Panama.

Publication of the amended sanitary regulations for the cities of Panama and Colon in the Official Gazette.

Street cleaning and garbage collection in the City of Panama.

Ordinance respecting the registration of births and deaths.

Proposed cancellation of land leases held by the Republic of Panama in Colon.

Matter of having funds collected from fines, penalties, and forfeitures, imposed or declared under the provisions of the sanitary rules and regulations, at the disposition of the alcaldes and health officers of the cities of Panama and Colon.

Preservation of the neutrality of the Canal Zone.

Work performed for the National Exposition at Panama.

Condemnation of buildings in Colon owned by Messrs. Erhman & Co. on account of nonrepair and noncompliance with the sanitary regulations.

Opening of new streets in the neighborhood of Chorillo, Panama City, with sewer installations, and installation of a new sewer main.

Immigration of undesirables.

Sale of intoxicating liquors to San Blas Indians.

Free railroad transportation for Panaman Government officials and employees.

Regulation of traffic over Gatun Lake.

Payment of duty to the Republic of Panama on sales of supplies to vessels which pass through the canal and which do not belong to the United States.

Transfer of a church building located at New Gatun to Limon.

Demolition, for sanitary reasons, of stables located in unimproved sections of the City of Panama.

Opium traffic in the Canal Zone and the cities of Panama and Colon.

Changing of the characteristics of the lighthouse at Taboga Island.

Matter of office space for the health officer of The Panama Canal in the old administration building in the City of Panama.

Requirement of having small coastwise vessels from Colombian ports pass through quarantine on account of yellow fever epidemic.

Detail of an expert accountant by The Panama Canal to undertake jointly with the chairman of the tribunal of accounts of the Republic of Panama an examination of the books of the national bank.

Difficulty in securing postage stamps from the Panaman Government, and the furnishing of stamped envelopes and stamp books.

Deposit to be made by the Republic of Panama, against which small sales of material by The Panama Canal may be charged.

Matter of imposing a penalty for wireless installations in Panama.

Renewal of the commissary privilege to certain officials of the Republic of Panama and members of the diplomatic corps, and the cancellation of the privilege for various institutions, etc.

Objection to the establishment of saloons in Colon near the boundary line.

Unsanitary condition of the towns on the San Blas coast.

Matter of denying permission to inhabitants of Arraijan to use canal land temporarily for grazing and agricultural purposes.

Notification to parties who have made cultivations between the 87-foot and the 100-foot contour lines, or on the peninsulas and islands in Gatun Lake, that they would be permitted to gather the present year's crop, but that no further planting should be made by them.

Reciprocal license fees on motor vehicles licensed in the Canal Zone and in the City of Panama.

Importation of playing cards and tobacco for employees free of customs duty.

Unsanitary conditions existing at Bocas del Toro.

Overcrowded condition of Santo Tomas Hospital and the urgent necessity of providing additional accommodations for the sick, particularly those suffering from tuberculosis.

Necessity for improvements in the condition of streets in the City of Panama, and the matter of allowing only streets with an asphalt surface of concrete or of paving brick to be constructed in future.

Taking over by the United States of a certain tract of land in the vicinity of the mouth of the Chagres River.

Transfer of a motor vehicle which was imported by an employee to a nonemployee, or its change from a pleasure license to a com-

mercial license, to be conditioned upon the presentation of a receipt evidencing the payment of customs duty on the car to the Panaman Government.

Free transportation of Panaman police officers assigned to duty on the island of Taboga on Panama launch plying between the ports of Balboa and Taboga.

Urgent necessity for additional public lavatories for men and women in the City of Panama.

Authority for the sale of certain machinery and equipment to the Pan American Timber & Lumber Co. without the customary certificate from the Association of Commerce of Panama, such material to be exempt from customs duty.

Location of the statue of Christopher Columbus at the Atlantic entrance of the canal.

Inspection of the Chiriqui Railroad by a competent engineer to be selected by The Panama Canal.

Examination of horses in such localities in the Republic of Panama as are reported contaminated by the epidemic disease (Murrina).

Exemption of Panama Canal wiremen working in Panama from requirement that they shall have licenses from the Republic of Panama.

Denial of the request that the Wilcox Wharf be allowed to remain until the construction of a small landing pier is completed at Boca Chica or Fox River on the southern side of Manzanillo Island.

Free entry of all shipments of material intended for the American Bible Society building at Cristobal.

Refund of consular fees on Panama Canal shipments by the Republic of Panama.

Reduction of the stock of Panamanian pesos in circulation by 1,000,000 for the benefit of the Panaman Government, The Panama Canal, and business interests generally.

Proposed common incinerator for disposing of garbage from Balboa, Ancon, and the City of Panama.

Delay to Panamanian mail after arrival at Cristobal.

Proposed detail of a member of the Canal Zone police to act as instructor for the National Police of Panama.

Approval of request to allow inhabitants of that section to clear parts of the old road from Arraijan to Pedro Miguel, and of the old San Juan Hill road.

Matter of keeping a record of autopsies performed in the cities of Panama and Colon.

Supervision of the Panamanian elections.

Prohibition of gambling in the cities of Panama and Colon.

Deportation of undesirable Americans.

#### LEGISLATION.

An appendix to the Governor's report contains the acts of Congress affecting The Panama Canal and the Executive orders relating to the Canal Zone.

Respectfully submitted.

C. A. McILVAINE,  
*Executive Secretary.*

Maj. Gen. GEO. W. GOETHALS, United States Army,  
*Governor, The Panama Canal, Balboa Heights, Canal Zone.*

TABLE NO. 1.—*Statement of vessels entered and cleared and of seamen shipped and discharged at Balboa and Cristobal, fiscal year 1916.*

	Vessels entered.			Vessels cleared.			Seamen shipped.			Seamen discharged.		
	Balboa.	Cristobal.	Total.	Balboa.	Cristobal.	Total.	Balboa.	Cristobal.	Total.	Balboa.	Cristobal.	Total.
<b>1915.</b>												
July.....	109	169	278	108	174	282	2	182	184	19	148	167
August.....	109	166	275	109	164	273	4	167	171	3	156	159
September.....	110	154	264	87	155	242	5	170	175	5	183	188
October.....	75	83	158	73	82	155	63	216	279	32	180	262
November.....	26	57	83	48	56	104	15	185	200	37	209	246
December.....	31	52	83	35	58	93	29	186	215	21	168	189
<b>1916.</b>												
January.....	47	58	105	39	50	89	10	226	236	14	226	240
February.....	32	50	82	40	50	90	13	186	199	10	154	164
March.....	59	58	117	53	57	110	17	236	253	23	212	235
April.....	70	107	177	79	106	185	11	230	241	9	200	209
May.....	105	146	251	106	137	243	4	189	193	5	200	205
June.....	120	137	257	115	142	257	6	279	285	7	204	211
<b>Total.....</b>	<b>893</b>	<b>1,237</b>	<b>2,130</b>	<b>892</b>	<b>1,231</b>	<b>2,123</b>	<b>179</b>	<b>2,452</b>	<b>2,631</b>	<b>235</b>	<b>2,240</b>	<b>2,475</b>

TABLE NO. 2.—*Statement showing number of estates received and settled and amount of funds handled during fiscal year ended June 30, 1916.*

By months.	Number received.	Number settled.	Amount of funds collected.	Value of estates settled.
Balance of unsettled estates and cash on hand on July 1, 1915.....	14	.....	\$3,643.89	.....
<b>1915.</b>				
July.....	16	24	478.65	\$1,657.54
August.....	25	14	560.34	260.57
September.....	18	14	382.12	239.41
October.....	13	17	1,001.12	1,019.32
November.....	13	12	1,111.57	689.81
December.....	24	18	625.18	636.19
<b>1916.</b>				
January.....	19	30	923.31	777.40
February.....	19	11	327.36	493.79
March.....	21	17	1,180.91	258.71
April.....	17	19	735.90	1,473.62
May.....	18	23	387.66	952.14
June.....	19	9	712.62	409.58
<b>Total estates and cash handled.....</b>	<b>236</b>	<b>208</b>	<b>12,070.63</b>	<b>8,868.08</b>

Number of unsettled estates on hand June 30, 1916..... 28  
 Balance of cash on deposit with collector on June 30, 1916..... \$3,227.05

TABLE NO. 3.—*Statement showing number of estates of deceased and insane employees, by nationalities, settled by administrator of estates during fiscal year ended on June 30, 1916.*

Native of—	Deceased.	Insane.	Total.
Colombia.....	3	.....	3
Costa Rica.....	1	.....	1
East India.....	1	.....	1
England.....	1	.....	1
Honduras.....	1	.....	1
Panama.....	13	.....	13
Peru.....	1	.....	1
Russia.....	.....	1	1
Spain.....	1	.....	1
United States.....	20	2	22
West Indies, British.....	152	2	154
West Indies, Danish.....	1	.....	1
West Indies, Dutch.....	1	.....	1
West Indies, French.....	7	.....	7
	203	5	208

TABLE NO. 4.—*Statement of number of free entry requests on freight shipments approved during fiscal year ended June 30, 1916, together with commodities imported.*

	Number.		Number.
Automobiles.....	163	Live stock and supplies.....	54
Automobile supplies.....	234	Miscellaneous.....	596
Baby carriages.....	15	Motorcycles and supplies.....	105
Bicycles.....	68	Motors, batteries, magnetos, etc.....	55
Cameras.....	8	Musical instruments, pianos, organs, etc.....	358
Canoes.....	8	Sewing machines.....	88
Clothing.....	58	Typewriters.....	94
Guns, rifles, pistols, and supplies.....	25		
Household goods.....	635	Total.....	2,566

TABLE NO. 5.—*Number of mail parcels on which duty has been paid to the Government of Panama, and the amount of duty as shown by receipts on file, by offices, during the fiscal year ended June 30, 1916.*

Name of post office.	Number of parcels.	Amount of duty.
Ancon.....	5,618	\$5,673.00
Balboa.....	275	236.33
Balboa Heights.....	24	30.81
Corozal.....	23	14.15
Cristobal.....	2,088	2,867.56
Culebra.....	86	38.11
Empire.....	192	139.07
Fort Randolph.....	.....	.....
Fort Sherman.....	5	2.40
Gamboa.....	.....	.....
Gatun.....	58	68.17
Las Cascadas.....	82	96.68
Monte Lirio.....	.....	.....
Paraiso.....	183	356.85
Pedro Miguel.....	20	34.06
Total.....	8,654	9,557.19

TABLE NO. 6.—*Number of insured and C. O. D. parcel-post parcels and registered articles delivered, by offices, during fiscal year ended June 30, 1916.*

Name of post office.	Number of insured and C. O. D. parcels.	Number of registered articles.	Total.
Ancon.....	3,492	13,027	16,519
Balboa.....	1,693	7,688	9,381
Balboa Heights.....	1,611	24,926	26,537
Corozal.....	416	3,150	3,566
Cristobal.....	2,889	23,985	26,874
Culebra.....	528	1,938	2,466
Empire.....	812	1,961	2,773
Fort Randolph.....		68	68
Fort Sherman.....	105	285	390
Gamboa.....	38	2,307	2,345
Gatun.....	676	4,318	4,994
Las Cascadas.....	562	1,348	1,910
Monte Lirio.....	3	72	75
Paraiso.....	597	4,323	4,920
Pedro Miguel.....	467	3,871	4,338
Total.....	13,889	93,267	107,156

TABLE NO. 7.—*Letters and parcels registered, by offices, during the fiscal year ended June 30, 1915.*

Name of post office.	Domestic letters registered.	Domestic parcels registered.	Foreign letters registered.	Foreign parcels registered.	Official registered free.	Distribution registered free.	Total.
Ancon.....	5,929	937	10,397	1,030	4,535	556	23,384
Balboa.....	2,290	405	2,445	104	4,088	213	9,545
Balboa Heights.....	1,386	208	474	80	38,719	69	40,936
Corozal.....	382	106	322	18	1,478	68	2,374
Cristobal.....	6,058	749	11,303	449	8,920	631	28,110
Culebra.....	775	201	500	7	1,007	2	2,492
Empire.....	852	221	339	5	792	24	2,233
Fort Randolph.....	23	48			40	23	139
Fort Sherman.....	170	56	50	3	334	164	777
Gamboa.....	269	19	263	17	621	12	1,201
Gatun.....	605	122	741	12	2,422	77	3,979
Las Cascadas.....	672	224	219	20	718	51	1,904
Monte Lirio.....	5		10		8		23
Paraiso.....	815	85	1,110	69	2,717	168	4,964
Pedro Miguel.....	317	69	251	11	1,960	30	2,638
Total.....	20,548	3,450	28,424	1,825	68,359	2,093	124,699

TABLE NO. 8.—*Number and destination of dispatches of mail by the exchange office at Cristobal during the fiscal year ended June 30, 1916.*

Destination.	Number of dispatches.	Destination.	Number of dispatches.
New York, by Panama Railroad and United Fruit Co. steamers.....	116	Grenada.....	23
New Orleans.....	57	Montserrat.....	19
Jamaica.....	76	Nevis.....	17
Barbados and distribution.....	23	St. Kitts.....	16
Trinidad and distribution.....	25	St. Lucia.....	23
French Lines, Colon-Bordeaux, Colon-St. Nazaire.....	20	St. Vincent.....	23
Martinique.....	24	Colombia.....	55
Guadeloupe.....	7	Costa Rica.....	82
Antigua.....	23	Colon, Republic of Panama.....	501
British Guiana.....	19	Boas del Toro, Republic of Panama.....	95
Demerara.....	3	Venezuela.....	1
Dominica.....	18	Cuba.....	74
		Total.....	1,430



TABLE NO. 9.—*Number of pouches, sacks, and registered sacks handled by railway-mail messengers during the fiscal year ended June 30, 1916.*

Month.	Pouches.	Sacks.	Registered sacks.	Total.
1915.				
July.....	4,607	1,205	477	6,289
August.....	4,436	1,747	503	6,686
September.....	4,214	1,465	493	6,172
October.....	4,523	1,693	508	6,724
November.....	4,377	1,756	539	6,672
December.....	5,011	2,880	821	8,712
1916.				
January.....	4,472	2,131	556	7,159
February.....	4,369	1,861	577	6,807
March.....	4,673	1,774	597	7,044
April.....	4,022	1,540	530	6,092
May.....	4,268	2,491	608	7,367
June.....	4,083	2,109	609	6,801
Total.....	53,055	22,652	6,818	82,525

TABLE NO. 10.—*Amount of money orders, by offices, payable to the remitter and drawn on the issuing office, remaining unpaid on June 30, 1916.*

Name of post office.	Deposit paid money orders.	Nontransferable deposit money orders.	Total.
Ancon.....	\$2,585.03	\$49,975.00	\$52,560.03
Balboa.....	3,375.15	71,105.00	74,480.15
Balboa Heights.....	11.50	20,455.00	20,466.50
Corozal.....	516.50	17,100.00	17,616.50
Cristobal.....	1,563.00	66,520.00	68,083.00
Culebra.....	1,759.40	8,775.00	10,534.40
Empire.....	1,097.05	7,685.00	8,782.05
Gatun.....	596.92	20,695.00	21,291.92
Las Cascadas.....	.....	10,060.00	10,060.00
Paraiso.....	731.50	50,230.00	50,961.50
Pedro Miguel.....	430.75	28,050.00	28,480.75
Total.....	12,666.80	350,650.00	363,316.80

TABLE NO. 11.—*Deposit money-order and postal-savings transactions during fiscal year ended June 30, 1916.*

Offices.	Deposit money orders.			
	Balance on deposit June 30, 1915.	Issued.	Paid.	Balance on deposit June 30, 1916.
Ancon.....	\$40,895	\$150,970	\$141,890	\$49,975
Balboa.....	73,615	241,150	243,660	71,105
Balboa Heights.....	19,860	82,480	81,885	20,455
Corozal.....	32,420	40,315	55,635	17,100
Cristobal.....	87,265	186,735	207,480	66,520
Culebra.....	6,375	26,820	24,420	8,775
Empire.....	8,200	48,920	49,435	7,685
Gatun.....	21,850	74,195	75,350	20,695
Las Cascadas.....	9,465	41,240	40,645	10,060
Paraiso.....	33,880	134,675	118,325	50,230
Pedro Miguel.....	19,065	73,690	61,705	28,050
Total.....	352,890	1,101,190	1,103,430	350,650

TABLE No. 11.—*Deposit money-order and postal-savings transactions during fiscal year ended June 30, 1916—Continued.*

Offices.	Postal savings certificates.				
	Balance unpaid July 1, 1915.	Transfers in.	Transfers out.	Withdrawals.	Balance on deposit June 30, 1916.
Ancon.....	\$40,180	\$2,281		\$28,989	\$13,472
Balboa.....	10,419		\$208	10,201	10
Balboa Heights.....					
Corozal.....	28,838		2,073	26,765	
Christobal.....	7,089	4		6,837	256
Culebra.....					
Empire.....					
Gatun.....	11,440		4	11,436	
Las Cascadas.....					
Paraiso.....	7,844			7,827	17
Pedro Miguel.....	18,851			18,305	546
Total.....	124,661	2,285	2,285	110,360	14,301

TABLE No. 12.—*Business of Canal Zone postal system for the fiscal year ended June 30, 1916.*

Offices.	Money orders.			
	Number of orders issued.	Amount of orders issued.	Amount of fees.	Total amount money orders paid.
Ancon.....	38,941	\$686,148.17	\$2,981.69	\$254,804.40
Balboa.....	27,520	649,215.07	2,091.96	295,137.37
Balboa Heights.....	13,868	347,689.14	1,253.70	166,061.07
Corozal.....	4,691	99,355.21	322.00	65,398.18
Christobal.....	42,445	860,324.88	3,512.26	293,897.27
Culebra.....	4,475	66,408.84	254.78	35,790.86
Empire.....	7,095	105,402.52	373.38	65,938.87
Gatun.....	8,994	165,218.76	549.74	92,980.59
Las Cascadas.....	4,965	81,443.11	257.83	51,074.46
Paraiso.....	11,897	308,665.55	871.40	129,805.65
Pedro Miguel.....	6,202	148,352.58	409.55	74,348.91
Fort Randolph.....				
Fort Sherman.....				
Gamboa.....				
Monte Lirio.....				
Storekeeper, S. D., Balboa.....				
Republic of Panama.....				
Total.....	171,096	3,518,223.83	12,878.29	1,525,236.73

Offices.	Postal receipts.			
	Stamp sales.	Box rents.	Second-class postage.	Total.
Ancon.....	\$21,602.13	\$1,332.00	\$1,410.25	\$21,344.38
Balboa.....	8,569.50	614.50		9,484.00
Balboa Heights.....	4,103.87	919.00		5,022.87
Corozal.....	1,851.64	42.50		1,894.14
Christobal.....	22,700.00	1,128.00	.14	23,828.14
Culebra.....	2,457.00	151.50		2,608.50
Empire.....	3,323.00	140.00		3,463.00
Gatun.....	2,964.00	176.00		3,140.00
Las Cascadas.....	3,018.00	51.50		3,069.50
Paraiso.....	2,861.75	366.50		3,228.25
Pedro Miguel.....	1,347.53	107.00		1,454.53
Fort Randolph.....	88.25	1.00		89.25
Fort Sherman.....	447.00			447.00
Gamboa.....	444.63			444.63
Monte Lirio.....	19.28			19.28
Storekeeper, S. D., Balboa.....	225.00			225.00
Republic of Panama.....	14.50			14.50
Total.....	76,337.08	5,029.50	1,410.39	82,776.97

TABLE NO. 13.—*Postal receipts and expenses.*

## POSTAL RECEIPTS.

	1915	1916
Stamp sales.....	\$74,843.88	\$76,337.08
Second-class mail.....	988.50	1,410.39
Money-order fees.....	13,169.55	12,878.29
Miscellaneous receipts.....	67.78	
Panama Railroad mail.....	3,750.00	1,200.00
Box rents.....	2,974.65	5,029.50
Total.....	95,794.36	96,855.26

## POSTAL EXPENSES.

Salaries.....	\$86,801.29	\$82,030.55
Transportation of mails.....	24,976.07	24,045.50
Purchase of stamps.....	28,385.60	27,207.86
Corral service.....	4,315.23	2,218.85
Stationery, printing, etc.....	3,077.05	2,552.25
Repairs to buildings.....	290.38	1,311.64
Furniture and fixtures.....	1,416.99	488.42
Electric light and electrical repairs.....	560.49	460.45
Miscellaneous.....	1,298.49	1,036.88
Total.....	151,121.59	141,382.40

Deficit, 1915.....	\$55,327.23
Deficit, 1916.....	44,527.14

TABLE NO. 14.—*Total cash transactions of Canal Zone postal system for fiscal year ended June 30, 1916.*

Total amount of money orders issued.....	\$3,518,223.83
Total fees on money orders issued.....	12,878.29
Total amount of money orders paid and repaid.....	1,525,236.73
Total amount of postal receipts.....	82,776.97
Total amount of postal savings certificates paid.....	110,360.00
Grand total cash transactions.....	5,249,474.82

TABLE NO. 15.—*Free entry requests on freight shipments, July 1, 1915, to June 30, 1916.*

Automobiles.....	165
Automobile supplies.....	234
Baby carriages.....	15
Bicycles.....	68
Cameras.....	8
Canoes.....	8
Clothing.....	58
Guns, rifles, pistols, and supplies.....	25
Household goods.....	635
Live stock and supplies.....	54
Miscellaneous.....	596
Motor cycles and supplies.....	105
Motors, batteries, magnetos, etc.....	55
Musical instruments, pianos, organs, etc.....	358
Sewing machines.....	88
Typewriters.....	94
Total.....	2,566

TABLE NO. 16.—*Police force as on June 30, 1916.*

Official title.	Author- ized force.	Actual force.
Police inspector.....	1	1
Captains.....	3	3
Lieutenants.....	5	5
Sergeants.....	12	12
First-class policemen:		
Authorized—		
General duty.....	75	
Panama Railroad service.....	23	
Special authority.....	41	
Actual—	139	
General duty.....	75	
Panama Railroad service.....	16	
Special authority.....	12	
Policemen (silver).....	34	103
	194	158

TABLE NO. 17.—*Distribution of police force by stations and substations.*

Stations and substations.	Actual force.		Stations and substations.	Actual force.	
	On July 1, 1915.	On June 30, 1916.		On July 1, 1915.	On June 30, 1916.
Headquarters.....	3	3	Cristobal central station.....	46	38
Detective force.....	4	4	Frijoles.....	1	1
Balboa central station.....	42	40	Monte Lirio.....	1	1
Ancon.....	9	9	Gamboa.....	1	1
Corozal.....	6	.....	Gatun.....	13	15
Pedro Miguel.....	31	33	Penitentiary.....	18	14
Culebra.....	1	.....	Total.....	176	158

TABLE NO. 18.—*Strength of police force by months during fiscal year ended June 30, 1916.*

Month.	Actual force.	Special duty.	Sick.	On leave.	Sus- pended.	Total.
1915.						
July.....	65	73	1	13	.....	152
August.....	69	73	.....	11	.....	153
September.....	66	73	.....	14	.....	153
October.....	68	78	.....	3	.....	149
November.....	72	75	.....	1	.....	148
December.....	74	74	.....	2	.....	150
1916.						
January.....	70	73	2	8	.....	153
February.....	68	73	1	11	.....	153
March.....	56	77	4	15	.....	152
April.....	98	88	.....	6	.....	192
May.....	81	87	2	8	.....	178
June.....	77	72	1	8	.....	158

Average actual force available for general duty, not including officers sick or on annual leave.....	72
Average number on special duty per month.....	76
Average number sick per month.....	1
Average number on leave per month.....	8.5
Average number suspended per month.....	0

TABLE NO. 19.—*Changes in police personnel during the fiscal year ended June 30, 1916.*

APPOINTMENTS.	
White:	
Appointed in the United States.....	2
Appointed on the Isthmus.....	71
Colored: Appointed on the Isthmus.....	8
Total.....	81
SEPARATIONS.	
White.....	68
Colored.....	8
Total.....	76
CAUSES FOR SEPARATIONS.	
Resigned.....	36
Discharged for cause.....	6
Discharged account reduction of force.....	22
Transferred.....	12
Total.....	76

TABLE NO. 20.—*Fines imposed on police officers for violations of the police rules and regulations during the fiscal year ended June 30, 1916.*

Month.	Number of white.	Amount.	Number of colored.	Amount.	Total amount.
1915.					
July.....	1	\$5			\$5
August.....	2	5			5
September.....	2	15			15
October.....	1	5	1	\$3	8
November.....	1	20			20
December.....	1	10			10
1916.					
January.....					
February.....	1	5			5
March.....	1	5	1	1	6
April.....					
May.....	4	20			20
June.....	1	10			10
Total.....	15	100	2	4	104

TABLE NO. 21.—*Number of arrests, by fiscal years, made in Canal Zone since organization.*

Period.	Arrests.	Period.	Arrests.
June 2, 1904, to June 30, 1905.....	2,130	July 1, 1911, to June 30, 1912.....	7,055
July 1, 1905, to June 30, 1906.....	3,748	July 1, 1912, to June 30, 1913.....	6,827
July 1, 1906, to June 30, 1907.....	5,831	July 1, 1913, to June 30, 1914.....	4,911
July 1, 1907, to June 30, 1908.....	6,075	July 1, 1914, to June 30, 1915.....	5,157
July 1, 1908, to June 30, 1909.....	6,275	July 1, 1915, to June 30, 1916.....	4,480
July 1, 1909, to June 30, 1910.....	6,947	Total arrests made to date.....	65,395
July 1, 1910, to June 30, 1911.....	5,959		

TABLE NO. 22.—*Number of arrests, by months, made during the fiscal year ended June 30, 1916.*

Month.	Males.	Females.	Total.	With warrant.	Without warrant.
1915.					
July.....	331	16	347	58	289
August.....	362	19	381	61	320
September.....	453	15	468	92	376
October.....	358	21	379	74	305
November.....	366	17	383	47	336
December.....	403	24	427	42	385
1916.					
January.....	373	34	407	71	336
February.....	269	27	296	82	214
March.....	316	33	349	87	262
April.....	326	16	342	61	281
May.....	284	33	317	71	246
June.....	365	19	384	68	316
Total.....	4,206	274	4,480	814	3,666

TABLE NO. 23.—*Arrests by stations during the fiscal year ended June 30, 1916.*

Station.	Total number fiscal year.	Station	Total number fiscal year.
Balboa Central.....	1,536	Cristobal Central.....	1,797
Ancon.....	323	Gatun.....	365
Corozal.....	44	Frijoles.....	7
Pedro Miguel.....	379	Monte Lirio.....	13
Paraiso.....	5	Gamboa.....	11
		Total.....	4,480

TABLE NO. 24.—*Charges against persons arrested during the fiscal year ended June 30, 1916.*

Offense.	Male.	Female.	Total.	Offense.	Male.	Female.	Total.
Aiding the commission of a felony.....	1		1	Carrying concealed weapons.....	12		12
Aiding a misdemeanor.....	2		2	Carrying firearms without a permit.....	9		9
Alighting from moving train.....	75	1	76	Civil order of arrest.....	5		5
Allowing ferocious dog at large.....	1		1	Conspiracy.....	5		5
Arson.....	3		3	Conspiracy to defraud.....	2		2
Assault.....	20		20	Contempt of court.....	40	2	42
Assault and battery.....	222	24	246	Crime against nature.....	6		6
Assault with a deadly weapon.....	16	1	17	Criminal negligence.....	1		1
Assault with means and force likely to produce great bodily harm.....	1		1	Cruelty to animals.....	55		55
Attempt to commit burglary.....	1		1	Desertion from United States Army.....	46		46
Attempt to commit grand larceny.....	1		1	Desertion from merchant vessel.....	6		6
Attempt to commit crime against nature.....	1		1	Destroying boundary mark.....	1		1
Attempt to commit petit larceny.....	10		10	Disorderly conduct.....	674	146	820
Attempt to defraud.....	31		31	Disturbing the peace.....	66	21	87
Attempt to escape.....	1		1	Embezzlement.....	15		15
Battery.....	130	26	156	Escaping from custody.....	3		3
Boarding a moving train.....	58		58	Exhibiting obscene picture.....	6		6
Bigamy.....	1		1	False personation.....	13		13
Bringing stolen property into Canal Zone.....	16	1	17	Fighting.....	119	9	128
Bribery.....	4		4	Forgery.....	8		8
Burglary.....	22		22	Fraud.....	20	1	21
				Fugitive from justice.....	17		17
				Gambling.....	79		79
				Grand larceny.....	66	2	68
				Having firearms without a permit.....	8		8
				Held for deportation.....	92		92

TABLE NO. 24.—Charges against persons arrested during the fiscal year ended June 30, 1916—Continued.

Offense.	Male.	Female.	Total.	Offense.	Male.	Female.	Total.
Held for extradition.....	1		1	Returning to Canal Zone after deportation.....	4		4
Held for order of consular court.....	10		10	Riding on platform of train.....	17		17
Held for Panamanian authorities.....	14		14	Robbery.....	3		3
Held for Peruvian consul.....	1	1	2	Straggling from United States Army.....	10		10
Held for quarantine authorities.....	50		50	Straggling from United States Navy.....	2		2
Hunting with artificial light.....	8		8	Trespass.....	24		24
Hunting without a permit.....	5		5	Trespass on train.....	40		40
Indecent exposure.....	14		14	Unauthorized riding on labor train.....	40	8	48
Intimidating a witness.....	1		1	Vagrancy.....	182	1	183
Intoxication.....	119		119	Violation of:			
Intoxication and disorderly.....	143	3	146	Automobile regulations.....	42		42
Insanity.....	4		4	Bicycle regulations.....	11		11
Larceny.....	1		1	Bird law.....	5		5
Lewd and lascivious cohabitation.....	8	8	16	Building regulations.....	10		10
Loitering.....	611	7	618	Coach tariff regulations.....	58		58
Malicious mischief.....	61	1	62	Chaufeur's ordinance.....	23	1	24
Mayhem.....	2		2	Customs regulations.....	7		7
Material witness.....	2		2	Impounding ordinance.....	4		4
Murder.....	4	1	5	License regulations.....	40	1	41
Nonsupport.....	19		19	Liquor regulations.....	18	1	19
Obscene and indecent language.....	1		1	Lottery law.....	3		3
Obtaining money by false pretenses.....	7		7	Navigation regulations.....	19		19
Perjury.....	3		3	Opium Act.....	35		35
Petit larceny.....	445	4	449	Postal regulations.....	6	1	7
Rape.....	2		2	Quarantine regulations.....	29		29
Receiving stolen property.....	7		7	Sanitary regulations.....	106	4	110
Reckless driving.....	5		5	Speed regulations.....	77	1	78
Reckless riding.....	8		8	Traffic regulations.....	6		6
Resisting an officer.....	9		9	Water regulations.....	3		3
				Total.....	4,380	277	4,657

TABLE NO. 25.—Statement of convictions of persons arrested during fiscal year ended June 30 1916.

Months.	Total number of arrests.	Convicted.	Dismissed.	Continued.	Died while in custody.	To insane asylum.	To military and naval authorities.	To quarantine authorities.	To Panama authorities.	Extradited.	Bail forfeited.	Deported.	Returned to merchant vessels.
1915.													
July.....	347	254	59				9	1	1		2	21	
August.....	381	290	83				5		2				1
September.....	468	350	91		1	1	10		1	1		11	2
October.....	379	268	60				7	1	7		1		35
November.....	383	315	43				4	3				18	
December.....	427	348	62				5	4			1	5	2
1916.													
January.....	407	290	76			1	5	14				2	19
February.....	296	215	64	1		1	3	3				3	6
March.....	349	259	63				3	14	6	1		3	
April.....	342	285	33	2			5	1	2	1		12	1
May.....	317	231	60	1			5	1	5		1	13	
June.....	384	284	73	7		1	3	1	3		3	9	
Total.....	4,480	3,389	767	11	1	4	64	43	27	3	8	97	66

TABLE NO. 26.—*Nationality of persons arrested during the fiscal year ended June 30, 1916.*

Nationality.	Total.	Nationality.	Total.
Africa.....	2	Great Britain and Possessions—Contd.	
Austria.....	8	British West Indies—Continued.	
Brazil.....	1	Nassau.....	13
Bolivia.....	3	Nevis Island.....	5
Chile.....	51	New Providence.....	21
China.....	103	St. Croix.....	1
Colombia.....	184	St. Kitts.....	31
Costa Rica.....	30	St. Lucia.....	60
Cuba.....	19	St. Vincent.....	40
Denmark.....	4	St. Andrews.....	1
Danish West Indies—		Tabago Island.....	1
Saba Island.....	1	Trinidad.....	71
St. Thomas.....	2	Turks Island.....	3
Ecuador.....	19	Greece.....	17
Egypt.....	2	Guatemala.....	5
France.....	7	Haiti.....	21
French Guiana.....	1	Holland.....	3
French West Indies—		Dutch Guiana.....	1
Guadeloupe.....	45	Curacao, D. W. I.....	1
Martinique.....	125	Honduras (Spanish).....	8
St. Martins.....	1	Italy.....	46
St. Bartholomew.....	1	Japan.....	2
Germany.....	28	Mexico.....	19
Great Britain and Possessions:		Nicaragua.....	14
Australia.....	3	Norway.....	21
British Guiana.....	45	Panama.....	295
British Honduras.....	1	Persia.....	2
Canada.....	4	Peru.....	92
Newfoundland.....	1	Portugal.....	4
England.....	41	Roumania.....	2
Gibraltar.....	1	Russia.....	9
India.....	28	Finland.....	11
Ireland.....	13	Santo Domingo.....	1
Scotland.....	1	Salvador.....	3
British West Indies—		Spain.....	87
Antigua.....	53	Canary Islands.....	2
Bahama.....	5	Sweden.....	21
Barbados.....	977	Switzerland.....	1
Bermuda.....	20	Turkey.....	1
Cayman.....	2	Syria.....	1
Dominica.....	8	United States.....	480
Fortune Island.....	30	Porto Rico.....	9
Grenada.....	66	Hawaii.....	3
Inagua.....	2	Venezuela.....	7
Jamaica.....	1,085		
Montserrat.....	20	Total (88 nationalities).....	4,480

TABLE NO. 27.—*Occupations of persons arrested during the fiscal year ended June 30, 1916.*

Occupation.	Number.	Occupation.	Number.
Actors.....	2	Cartmen.....	27
Agents.....	6	Checkers.....	6
Apprentices.....	4	Chemists.....	3
Artists.....	1	Cigar makers.....	2
Auditor.....	1	Civil engineers.....	5
Baggage-master.....	1	Clerks.....	64
Bakers.....	11	Coachmen.....	95
Barbers.....	8	Coal passers.....	6
Bartenders.....	2	Conductors.....	5
Bellboys.....	1	Contractors.....	4
Blacksmiths.....	8	Convicts (escaped).....	1
Boatmen.....	8	Cooks.....	38
Boilermakers.....	10	Coopers.....	1
Boilermakers' helpers.....	1	Cranemen.....	5
Boot blacks.....	5	Domestics.....	238
Brakemen.....	26	Donkeymen.....	1
Bricklayers.....	1	Draftsmen.....	1
Brokers.....	1	Dredgemen.....	3
Bridgmen.....	1	Dressmakers.....	1
Bullfighters.....	1	Drillmen.....	3
Butchers.....	12	Electricians.....	11
Cable splicers.....	1	Engineers:	
Carpenters.....	95	Civil.....	12
Charcoal burners.....	4	Locomotive.....	4
Chainmen.....	1	Steam.....	4
Chaufeurs.....	88	Marine.....	13



TABLE NO. 27.—*Occupations of persons arrested during the fiscal year ended June 30, 1916—Continued.*

Occupation.	Number.	Occupation.	Number.
Farmers.....	37	Palmists.....	1
Firemen.....	90	Patternmakers.....	1
Fishermen.....	27	Peddlers.....	64
Flagmen.....	4	Physicians.....	5
Foremen.....	62	Photographers.....	1
Gardeners.....	2	Pipefitters.....	1
Hairdressers.....	1	Plasterers.....	2
Hatters.....	1	Plumbers.....	5
Hostlers.....	2	Police-men.....	5
Housewives.....	4	Porters.....	3
Inspectors.....	2	Postmasters.....	1
Ironworkers.....	13	Powdermen.....	1
Janitors.....	13	Printers.....	1
Judges.....	1	Pump operators.....	1
Laborers.....	2, 075	Riggers.....	2
Land commissioners.....	1	Sailors.....	242
Land inspectors.....	1	Salesmen.....	11
Landresses.....	10	School children.....	3
Laundrymen.....	3	Secretaries.....	1
Lawyers.....	2	Ship officers.....	26
Lecturers.....	1	Shipwrights.....	1
Linemen.....	4	Shoemakers.....	16
Linotype operators.....	1	Singers.....	1
Levelmen.....	2	Soldiers.....	99
Machinists.....	37	Stablemen.....	1
Machinist helpers.....	2	Stevedores.....	2
Masons.....	17	Stewards.....	16
Merchants.....	29	Storekeepers.....	2
Messengers.....	26	Students.....	3
Messmen.....	1	Superintendents.....	1
Metal workers.....	2	Switchtenders.....	11
Ministers.....	1	Tailors.....	16
Molders.....	1	Teachers.....	1
Miners.....	2	Teamsters.....	12
Monks.....	2	Timekeepers.....	5
Musicians.....	1	Time inspectors.....	2
Moving-picture operators.....	1	Toolmakers.....	1
Newsboys.....	10	Traders.....	2
No occupation.....	435	Waiters.....	48
Officers of United States Army.....	1	Watch inspectors.....	1
Oilers.....	21	Watchmen.....	27
Operators:		Waterboys.....	4
Motor boat.....	3	Winchmen.....	2
Wireless.....	3	Wiremen.....	1
Opticians.....	1		
Painters.....	19	Total (106 occupations).....	4, 480

TABLE NO. 28.—*Number of prisoners in custody in common jails at the close of each month during the fiscal year ended June 30, 1916.*

Month.	Number of prisoners.	Month.	Number of prisoners.
1915.		1916.	
July.....	85	January.....	129
August.....	89	February.....	82
September.....	135	March.....	71
October.....	80	April.....	79
November.....	97	May.....	51
December.....	148	June.....	76

Average number in jail at close of each month, 84.

TABLE NO. 29.—*Statement showing number of records of persons who had been previously arrested, which were prepared and submitted to the courts during the fiscal year ended June 30, 1916.*

Month.	Number.	Month.	Number.
1915.		1916.	
July.....	67	January.....	107
August.....	98	February.....	59
September.....	101	March.....	58
October.....	74	April.....	68
November.....	106	May.....	70
December.....	95	June.....	53
		Total.....	956

TABLE NO. 30.—*Value of labor performed by Zone prisoners confined in the common jail during the fiscal year ended June 30, 1916.*

Stations.	Number of hours.			Total.	Amount at 10 cents an hour.
	Road work.	Janitor work.	Public grounds.		
Balboa central station.....		30,284	1,628	31,912	\$3,191.20
Ancon.....		1,208		1,208	120.80
Balboa fire station.....		1,464		1,464	146.40
Corozal.....		1,848		1,848	184.80
Pedro Miguel.....	62,710	13,314		76,024	7,602.40
Gamboa.....		1,392	3,320	4,712	471.20
Monte Lirio.....		936		936	93.60
Gatun.....		3,800	5,779	9,579	957.90
Cristobal.....		20,306	832	21,138	2,113.80
Cristobal fire station.....		2,010		2,010	201.00
Total.....	62,710	76,562	11,559	150,831	15,083.10

TABLE NO. 31.—*Animals impounded and fees collected during the fiscal year ended June 30, 1916.*

Month.	Horses.	Mules.	Cattle.	Goats.	Dogs.	Total.	Fees collected.
1915.							
July.....	10	3				13	\$18.50
August.....	11	2				16	38.80
September.....	7	2				9	16.00
October.....	8	4	1			13	16.50
November.....	19	2				21	48.50
December.....	17	3		2		22	35.50
1916.							
January.....	3	5				8	20.50
February.....	8	2	10	1		21	34.50
March.....	4	3				7	24.40
April.....	4	3	1			8	7.50
May.....	17					17	54.50
June.....	8	1				9	10.00
Total.....	119	30	12	3		164	325.20

TABLE NO. 32.—*Convicts discharged from penitentiary during fiscal year ended June 30, 1916.*

Month.	Number discharged.	Aggregate sentences served.		Good time earned.		
		Years.	Months.	Years.	Months.	Days.
1915.						
July .....	3	4	6		7	11
August .....	3	2	3		1	22
September .....	5	4	10		4	7
October .....	7	4	6		4	23
November .....	5	4	5		1	27
December .....	6	7.	3	1		10
1916						
January .....	4	4	6		4	17
February .....	8	7	10		8	13
March .....	4	3	3		3	15
April .....	7	3	--		5	6
May .....	8	15	9	2	10	16
June .....	6	4	6		1	9½
Total .....	66	66	7	7	5	26½

Number of convicts in penitentiary July 1, 1915 .....	58
Number received during fiscal year ended June 30, 1916 .....	59
Number discharged during fiscal year .....	66
Number of convicts in confinement on June 30, 1916 .....	51

TABLE NO. 33.—*Crimes committed by convicts confined in penitentiary on June 30, 1916, and their aggregate sentences.*

Number.	Crime.	Years.	Months.
5	Assault with deadly weapon .....	5	9
2	Assault with intent to commit rape .....	4	6
1	Bigamy .....	1	4
1	Bribery and grand larceny .....	3	4
2	Burglary .....	5	4
4	Burglary, first degree .....		9
1	Burglary, second degree, and returning to Canal Zone after being deported therefrom .....	4	4
3	Burglary and grand larceny .....	1	6
1	Embezzlement .....		6
1	False personation .....	3	6
2	Forgery .....	12	6
13	Grand larceny .....	2	6
1	Grand larceny, assault with deadly weapon, and burglary .....	5	6
1	Incest .....	12	6
2	Manslaughter .....	3	6
1	Mayhem .....	(1)	91
2	Murder, first degree .....	12	6
5	Murder, second degree .....		6
2	Rape .....		6
1	Returning to Canal Zone after being deported .....		8
51		167	

<sup>1</sup> Life.TABLE NO. 34.—*Nationality of the convicts confined in the penitentiary on June 30, 1916.*

Native of—	Number.	Native of—	Number.
Costa Rica .....	1	British West Indies:	2
St. Thomas, Danish West Indies .....	1	St. Kitts .....	1
French West Indies:		St. Lucia .....	1
Guadeloupe .....	1	Panama .....	8
Martinique .....	3	Peru .....	1
British West Indies:		Porto Rico .....	1
Barbados .....	12	Spain .....	1
Grenada .....	1	United States .....	4
Jamaica .....	13		
New Providence .....	1	Total .....	51

Fifteen nationalities.

TABLE NO. 35.—*Convicts received at penitentiary during the fiscal year ended June 30, 1916.*

Month.	Number received.	Aggregate sentences.	
1915.		Years.	Months.
July.....	2	1	10
August.....	4	2	1
September.....	3	1	3
October.....	8	6	10
November.....	4	2	8
December.....	5	2	9
1916.			
January.....	6	5	2
February.....	3	2	8
March.....	13	8	6
April.....	3	6	6
May.....	5	22	8
June.....	3	1	10
Total.....	59	64	9

TABLE NO. 36.—*Sentences of convicts confined in penitentiary on June 30, 1916.*

Range of sentences.	Black.	White.	White Americans.	Total.
Life imprisonment.....	2	.....	.....	2
10 years and over.....	5	.....	.....	5
5 years and over.....	5	.....	.....	5
4 years and over.....	1	.....	.....	1
3 years and over.....	1	.....	.....	1
2 years and over.....	4	.....	.....	4
1 year and over.....	16	1	1	18
Less than one year.....	10	.....	1	11
Less than six months.....	3	.....	1	4
Total.....	47	1	3	51

TABLE NO. 37.—*Convicts and Zone prisoners deported during fiscal year ended June 30, 1916.*

Deported to—	Convicts.	Zone prisoners.	Total.
Colombia.....	4	.....	4
Costa Rica.....	1	1	2
Martinique (French West Indies).....	2	.....	2
British West Indies:			
Barbados.....	11	7	18
Jamaica.....	10	6	16
Trinidad.....	2	1	3
Turks Island.....	1	.....	1
Italy.....	1	.....	1
Nicaragua.....	1	1	2
Mexico.....	1	.....	1
Panama.....	15	3	18
Peru.....	1	1	2
United States.....	3	23	26
Venezuela.....	.....	1	1
Total.....	53	44	97

TABLE NO. 38.—*Cost of subsisting, guarding, and clothing convicts confined in the penitentiary during fiscal year ended June 30, 1916.*

Month.	Subsistence.		Salaries of officers and guards.		Total.
	Convicts.	Guards.	Peniten- tiary.	Road work.	
1915.					
July.....	\$463.07	\$132.33	\$748.67	\$405.00	\$1,749.07
August.....	434.08	122.67	750.00	405.00	1,711.75
September.....	419.27	118.71	739.34	405.00	1,682.32
October.....	410.97	101.69	526.65	364.70	1,404.01
November.....	385.10	104.24	560.00	391.67	1,441.01
December.....	429.32	121.80	579.99	445.00	1,576.11
1916.					
January.....	407.83	114.81	560.00	445.00	1,527.64
February.....	379.10	108.82	548.66	430.33	1,466.91
March.....	385.00	110.72	574.00	441.00	1,510.72
April.....	441.30	118.60	544.67	445.60	1,549.57
May.....	422.79	109.07	516.00	409.00	1,456.86
June.....	357.38	92.86	525.34	474.33	1,449.91
Total.....	4,935.21	1,356.32	7,173.32	5,061.03	18,525.88

TABLE NO. 39.—*Value of the labor performed by convicts employed on public improvements and value of labor of convicts assigned to inside labor at the penitentiary during the fiscal year ended June 30, 1916.*

Month.	Description of outside labor.	Value of work performed.	Value of inside labor.
1915.			
July.....	Building Empire-Gamboa road	\$937.40	\$4.30
August.....	do.	888.20	63.20
September.....	do.	831.80	48.80
October.....	do.	902.20	16.80
November.....	do.	770.60	2.60
December.....	do.	907.20	.40
1916.			
January.....	do.	\$61.60	.80
February.....	do.	800.00	.....
March.....	do.	873.60	4.80
April.....	do.	858.60	3.20
May.....	do.	873.00	.....
June.....	do.	752.40	3.20
Total.....		10,236.60	148.10

The inside labor consisted of miscellaneous repairs to horse equipment for police and fire stations, repairing uniforms of Zone prisoners, and repairing mail sacks for the Canal Zone postal service.

TABLE NO. 40.—*Deaths, by months, investigated by coroner during fiscal year ended June 30, 1916.*

Month.	Number.	Month.	Number.
1915.			
July.....	9	January.....	6
August.....	9	February.....	8
September.....	5	March.....	14
October.....	6	April.....	7
November.....	8	May.....	8
December.....	7	June.....	7
Total.....			94

TABLE NO. 41.—*Causes of deaths investigated by the coroner during the fiscal year ended June 30, 1916.*

Causes.	Number.	Causes.	Number.
Drowning, accidental.....	39	Suicide.....	4
Electrocution, accidental.....	1	Suffocation, accidental.....	1
Hemorrhage.....	1	Traumatism, accidental.....	38
Homicide.....	5	Unknown, natural causes.....	2
Peritonitis.....	1	Total.....	94
Shock.....	1		
Shot, accidentally.....	1		

TABLE NO. 42.—*Nationality of persons whose deaths were investigated by the coroner during the fiscal year ended June 30, 1916.*

Nationality.	Number.	Nationality.	Number.
Chile.....	2	Great Britain—Continued.	
China.....	2	British West Indies:	
Colombia.....	4	Barbados.....	18
Ecuador.....	1	Fortune Island.....	1
French West Indies:		Grenada.....	1
Guadeloupe.....	1	Jamaica.....	28
Martinique.....	2	St. Lucia.....	1
Germany.....	3	St. Vincent.....	2
Holland: Curacao.....	1	Trinidad.....	1
Honduras.....	1	Panama.....	4
Great Britain:		Peru.....	3
England.....	1	Russia: Finland.....	1
Ireland.....	1	Spain: Canary Islands.....	1
Scotland.....	1	Unknown.....	2
British Guiana.....	1	United States.....	10
		Total.....	94

TABLE NO. 43.—*Fire personnel, June 30, 1916.*

Official title.	July 1, 1915.		June 30, 1916.	
	Author-ized.	Actual.	Author-ized.	Actual.
Fire inspector.....		1		1
Captains.....		2		2
Lieutenants.....		6		6
Motor inspector.....		1		1
Operators.....		4		4
Firemen.....		29		24
Total.....		43		38

TABLE NO. 44.—*Distribution of fire personnel, by stations, June 30, 1916.*

Stations.	Fire in-spector.	Captains.	Lieut en-ants.	Motor in-spector.	Operators.	Firemen.	Total paid force.	Volunteer firemen.	Total.
Headquarters.....	1						1		1
Balboa central station.....		1	2	1	1	6	11	18	29
Ancon.....			1		1	5	7		7
Corozal.....								9	9
Pedro Miguel.....						2	2	32	34
Paraiso.....						1	1	18	19
Cristobal central station.....		1	2		2	7	12		12
Gatun.....			1			3	4	9	13
Monte Lirio.....								2	2
Frijoles.....								1	1
Gamboa.....								15	15
Total.....	1	2	6	1	4	21	38	104	142

TABLE NO. 45.—*Enlistments and separations, fire force, during fiscal year ended June 30, 1916.*

Number of firemen appointed during the year.....	8
Number of separations from the service:	
Resigned.....	10
Discharged.....	3
Total.....	13

TABLE NO. 46.—*Statement of damage resulting from fire during the fiscal year ended June 30, 1916.*

	The Panama Canal.	Panama Railroad.	United States Army.	Private property in the Canal Zone.	Total.
1915.					
July.....	\$10.00		\$125.00		\$135.00
August.....	5.00				5.00
September.....	10.00				10.00
October.....	255.00			\$30.00	285.00
November.....				1,107.40	1,107.40
December.....	132.00			20,710.75	20,862.75
1916.					
January.....	50.00	\$4,531.00			4,581.00
February.....		15.00			15.00
March.....	403.00	36.25		1.00	440.25
April.....	15.00	759.95			774.95
May.....	60.00				60.00
June.....	142.12				142.12
Total.....	1,102.12	5,342.20	125.00	21,849.15	28,418.47

TABLE NO. 47.—*Statement of property involved in fires during the fiscal year ended June 30, 1916.*

Month.	The Panama Canal.	Panama Railroad.	United States Army.	Private property in the Canal Zone.	Total.
1915.					
July.....	\$353,076.25	\$1,800.00	\$750.00		\$355,626.25
August.....	11,012.00	370.00			11,382.00
September.....	106,072.39				106,072.39
October.....	52,650.00			\$4,950.00	57,600.00
November.....				351,007.40	351,007.40
December.....	47,412.27			370,800.00	418,212.27
1916.					
January.....	23,847.60	15,048.95			38,896.55
February.....	207,476.00	15,900.00			223,376.00
March.....	14,542.00	22,631.25		6,800.00	43,973.25
April.....	3,373.00	8,097.00			11,470.00
May.....	5,323.00				5,323.00
June.....	28,183.00				28,183.00
Total.....	852,967.51	63,847.20	750.00	733,557.40	1,651,122.11

TABLE NO. 48.—*By whom fires were extinguished.*

Alarms attended by paid and volunteer firemen.....	55
Fires extinguished by employees and occupants.....	27
Alarms attended in Panama City.....	3
Alarms attended in City of Colon.....	1
False alarms.....	11
Total.....	97

TABLE NO. 49.—*Classification of fires according to ownership of property*

Fires in property of The Panama Canal.....	49
Fires in property of the U. S. Army.....	1
Fires in Panama Railroad property.....	21
Fires in private property on the Canal Zone.....	7
Fires in dry grass, rubbish, dumps, etc.....	6
False alarms.....	11
Assisted Panama Fire Department.....	2
Total.....	97

TABLE NO. 50.—*Classification of fires by buildings.*

Cargo.....	2
Clubhouses.....	1
Docks.....	4
False alarms.....	11
Garages.....	1
Gas tanks.....	1
Grass, rubbish, etc.....	17
Health office (Panama).....	1
Hospital.....	1
Hotels.....	1
Dwellings.....	11
Lumber.....	6
Motor boats.....	2
Office buildings.....	2
Oil.....	2
Oil houses.....	2
Oil tanks.....	1
Pile drivers.....	2
Railroad cars.....	13
Railroad ties.....	4
Roundhouse.....	1
Steamships.....	3
Storehouses.....	4
Tool boxes.....	1
Towing locomotives.....	1
Tug.....	1
Transformer.....	1
Total.....	97

TABLE NO. 51.—*Classification of causes of fires.*

Burning of waste, rubbish, dry grass, etc.....	9
Chemical action.....	4
Chimneys.....	2
Cigars and cigarettes.....	4
Electric lights.....	1
Electric wires.....	7
False alarms.....	11
Hot box.....	1
Hot coals and ashes.....	1
Lamps.....	2
Lanterns.....	1
Sparks from locomotives.....	32
Sparks from rubbish fire.....	1
Spontaneous combustion.....	5
Stoves.....	2
Torches.....	1
Unknown.....	13
Total.....	97



TABLE NO. 52.—*Manner in which fires were extinguished.*

Allowed to burn out.....	4
Beat out.....	2
Burning articles removed.....	2
Burned out (outside of hydrant district).....	1
Earth and sand shoveled on fire.....	1
False alarms.....	11
Fire extinguishers.....	16
Fire extinguishers and pails of water.....	2
Fire extinguishers and sand.....	1
Garden hose.....	2
Line of hose.....	29
Line of hose and fire extinguishers.....	2
Lines of hose.....	2
Pails of water.....	19
Pails of water and sand.....	1
Assisted Panama fire department.....	2
Total.....	97

TABLE NO. 53.—*Distribution of alarms by towns.*

Balboa.....	39	Gamboa.....	6
Ancon.....	6	Mount Hope.....	3
La Boca.....	1	Culebra.....	1
Palo Seco.....	1	Gatun.....	8
Corozal.....	1	Cristobal.....	14
Miraflores.....	2	Colon.....	1
Pedro Miguel.....	7	Panama.....	3
Haute Obispo.....	1		
Paraiso.....	3	Total.....	97

TABLE NO. 54.—*Statement of fires and losses and property.*

Fiscal year.	Number of fires.	False alarms.	Total damage.	Total property involved.
1936-7.....	45	.....	\$100,000.00	\$1,300,000.00
1937-8.....	71	12	46,170.50	1,097,619.45
1938-9.....	92	6	16,934.92	1,624,893.65
1939-10.....	123	10	3,237.04	1,212,335.19
1910-11.....	238	14	53,877.44	2,256,210.01
1911-12.....	315	18	12,653.58	1,826,995.58
1912-13.....	232	18	22,520.97	1,041,430.19
1913-14.....	207	8	21,376.96	1,993,012.61
1914-15.....	142	13	153,286.95	2,465,654.18
1915-16.....	86	11	28,418.47	1,651,122.11

TABLE NO. 55.—*Distribution of fire equipment, June 30, 1916.*

Locations.	Hose reels.	Small carts.	Nozzles.		Fire extinguishers.		Feet rubber-lined fire hose.
			12-inch.	24-inch.	Pyrene.	Chemical.	
Balboa District.....	9	6	29	111	55	1,004	22,283
Cristobal District.....	3	10	17	123	43	339	19,378
Total.....	12	16	46	234	98	1,343	41,661

TABLE NO. 56.—*Fire hose and extinguishers, inspections of, etc., by months, fiscal year 1915-16.*

Month.	Fire hose.		Fire extinguishers.	
	Number of feet inspected.	Number of feet aired.	Number of inspections.	Number recharged.
1915.				
July.....	177,080	10,550	1,756	23
August.....	161,325	1,150	1,813	28
September.....	166,875	2,650	1,745	73
October.....	184,450	2,450	1,427	15
November.....	166,225	2,050	1,502	12
December.....	171,415	7,600	1,654	20
1916.				
January.....	181,200	7,900	1,529	14
February.....	172,525	2,400	1,860	15
March.....	186,250	5,150	1,956	35
April.....	180,125	2,450	1,711	35
May.....	197,120	1,050	2,040	37
June.....	190,750	2,050	1,678	3
Total.....	2,138,340	47,450	20,671	310

In service June 30, 1916:

Total number of feet of rubber-lined fire hose.....	41,661
Total number of 3-gallon and 5-gallon acid extinguishers.....	1,343
Total number of Pyrene extinguishers.....	98

TABLE NO. 57.—*Volunteer companies, June 30, 1916.*

Towns.	Number of companies.	Number of members.
Balboa District:		
La Boca.....	1	20
Corozal.....	1	15
Pedro Miguel.....	2	40
Paraiso.....	1	20
Cristobal District:		
Gatun.....	1	20
Monte Lirio.....	1	2
Frijoles.....	1	2
Gamboa.....	1	19
Total.....	9	138

TABLE NO. 58.—*Volunteer companies—Summary of drills and passes issued.*

Month.	Number of companies.	Number of members.	Present at drill.	Absent from drill.	Passes issued.
1915.					
July.....	8	122	99	23	99
August.....	8	123	89	34	86
September.....	8	117	82	35	82
October.....	8	115	94	21	94
November.....	8	116	102	14	102
December.....	9	138	119	19	119
1916.					
January.....	9	135	113	22	113
February.....	9	133	121	12	121
March.....	9	138	125	13	125
April.....	8	135	114	21	114
May.....	9	134	105	29	105
June.....	9	138	104	34	104
Total.....		1,544	1,267	277	1,264

Average number of members.....	129
Average attendance at drills.....	106
Average absence at drills.....	23
Total number of passes issued.....	1,264

TABLE NO. 59.—Summary of a house-to-house canvass of the population of the Canal Zone, taken between June 1 and 10, 1916, by the police and fire division.

## BALBOA DISTRICT.

Location.	Americans.		All others.		Americans.		All others.		Total.
	Men.	Em- ployees.	Men.	Em- ployees.	Women.	Child- ren.	Women.	Child- ren.	
Ancon.....	903	903	170	170	385	363	54	3	1,878
Ancon Hospital:									
Doctors.....	21	21							21
Nurses.....	5	5			66				71
Patients (except soldiers).....	38	33	260	160	27	5	61		391
Attendants.....	19	19	87	87			10		116
Tivoli Hotel.....	46	6	44	44	11	4	2		107
Pueblo Nuevo.....			48	22			60	49	157
Naos Island.....	10	10	46	46					56
Culebra Island.....									
Palo Seco.....	1	1	14	14	1		5		21
Patients, Palo Seco.....			32				18	12	62
Balboa, Balboa Heights, and La Boca.....	937	928	1,616	1,604	342	322	726	715	4,658
Quarantine Station.....	4	4	16	16	3	1			24
Balboa Harbor.....	3	3	6	6					9
Rural District.....			3				6	10	19
Corozal.....	28	28	111	111	15	6	17	12	159
Asylum.....	3	3			4	4			11
Doctors.....	3	3							3
Nurses.....	4	4			4				8
Patients.....	5		161				116		282
Attendants.....			25	25			12		37
Rural District.....			22	5			16	13	51
Pedro Miguel.....	233	233	80	80	122	144	59	53	691
Labor camps.....			206	206					206
Rural District, east and west of Canal prism.....			6				2	4	12
Red tank.....			76	76			75	91	242
Miraflores.....	28	28	47	47			24	31	130
Paraiso.....	320	320	227	213	79	90	183	230	1,129
Jamaica Town.....			204	182			136	127	467
Spanish Town.....			93	60			46	32	171
Floating equipment.....	84	84	420	420					504
Labor camps.....			471	471					471
Rural, from Paraiso to Gamboa.....	4	4	102	99	1	1	12	19	139
Culebra.....	9	5	3	3	5	4	24	3	48
Rio Grande.....			74	74			60	70	204
Enterprise.....			103	103			41	55	199
West Culebra.....									
Golden Green.....			109	17			113	92	314
Empire.....	8	8	126	18	6	4	97	112	353
Lirio Camp.....			99	98			68	92	259
Cerro Camp.....			69	63			71	103	243
Cunette.....									
Martinique Camp.....	1	1	74	21	1	2	66	61	205
Bas Obispo.....			40	40			22	19	81
Gamboa Stockade.....	7	7	8	8					15
Total employees.....		2,661		4,609		950			
Total persons.....	2,724		5,298		1,072		2,202	2,008	14,254

## CRISTOBAL DISTRICT.

Gamboa.....	25	24	88	88	6	4	20	21	164
Floating equipment.....	8	8	83	83					91
Darien.....			5	5			8	3	21
Frijoles.....	2	2	43	39	1		13	17	76
Monte Lirio.....	3	3	43	31	2	1	27	31	107
Gatun.....	223	219			180	222			625
Labor camps.....			238	238			120	210	568
New Gatun.....			1,088	878			742	704	2,534
Boca Mindi.....			2	2					2
Puerto Escondido.....			6	6					6
Marajual.....	1	1	44	43			4	3	52
Mount Hope.....	15	15	84	75	11	20	12	24	166
Cristobal.....	658	658	28	28	195	295			1,176
Folks River.....	16	7	351	314	10	8	234	317	966
Camp Bierd.....			1,683	1,683			37	98	1,818
Bracho.....			17	17					17
Toro Point.....			4	4			6	1	11
Total employees.....		937		3,534					
Total persons.....	951		3,807		405	550	1,223	1,459	8,395

TABLE No. 59.—*Summary of a house-to-house canvass of the population of the Canal Zone, taken between June 1 and 10, 1916, by the police and fire division—Continued.*

## GATUN LAKE AREA.

[Within Canal Zone.]

Location or section.	Americans.		All others.		Americans.		All others.		Total.
	Men.	Em- ployees.	Men.	Em- ployees.	Women.	Child- ren.	Women.	Child- ren.	
Upper Chagres.....									
Cano Quebrada.....			4				1		5
Agua Salud.....									
Trinidad River.....			5	1			6	3	14
Gatun River.....			3				1	8	12
Zorro Island.....			3				2	2	7
Total employees.....				1					
Total persons.....			15				10	13	38

## MILITARY ORGANIZATIONS.

## UNITED STATES ARMY.

Location.	Officers.	Enlisted men.	Women.	Children.	Total.
Ancon-Balboa Army Headquarters:					
Quarry Heights.....	16	190	10	9	225
Fort Grant.....	28	920	54	41	1,043
Corozal.....	44	1,008	76	63	1,191
Culebra.....	38	786	61	57	942
Empire.....	54	1,659	91	69	1,873
Las Cascadas.....	55	1,646	48	48	1,797
Gatun.....	13	250	19	15	297
Cristobal.....	4	20	9	11	44
Fort Randolph.....	11	218	19	28	306
Fort Sherman.....	15	425	17	12	469
Total persons.....	278	7,152	404	353	8,187

## UNITED STATES NAVY.

Darien radio station.....	1	15	3	2	21
Balboa radio.....		5	2	3	10
Total persons.....	1	20	5	5	31

## PRISONERS.

Location.	Americans.		All others.		Americans.		All others.		Total.
	Men.	Em- ployees.	Men.	Em- ployees.	Women.	Child- ren.	Women.	Child- ren.	
Balboa.....	2		21						23
Ancon.....			1						1
Pedro Miguel.....			39						39
Gamboa Penitentiary.....	3		49						52
Monte Lirio.....			1						1
Gatun.....			4						4
Cristobal.....	1		22						23
Total persons.....	6		137						143

TABLE NO. 59.—*Summary of a house-to-house canvass of the population of the Canal Zone, taken between June 1 and 10, 1916, by the police and fire division—Continued.*

## RECAPITULATION.

Location.	Americans.		All others.		Americans.		All others.		Total.
	Men.	Em- ployees.	Men.	Em- ployees.	Women.	Child- ren.	Women.	Child- ren.	
Balboa District.....	2,724	2,661	5,298	4,609	1,072	950	2,202	2,008	11,254
Cristobal District.....	951	937	3,807	3,534	405	550	1,223	1,459	8,395
Gatun Lake Area (with- in Canal Zone).....			15	1			10	13	38
Military organizations (including radio sta- tions).....	7,451				409	358			8,218
Prisoners.....	6		137						143
Total employees.....		3,598		8,144					
Total persons.....	11,132		9,257		1,886	1,858	3,435	3,480	31,048

TABLE NO. 60.—*Average daily attendance in schools and number of teachers employed in schools at close of each school year.*

	Average daily attendance for school year.			Number of teachers employed at close of school in June.		
	White.	Colored.	Total.	White.	Colored.	Total.
1904 <sup>1</sup> .....						
1905.....						5
1906.....			<sup>2</sup> 150			<sup>3</sup> 29
1907.....			<sup>3</sup> 1,107			<sup>4</sup> 31
1908.....			<sup>4</sup> 1,138			
1909.....	385	765	1,150	23	20	43
1910.....	539	748	1,287	32	21	53
1911.....	682	577	1,259	35	21	56
1912.....	838.8	556.1	1,394.9	43	24	67
1913.....	979.9	733.7	1,713.6	45	28	73
1914.....	1,029.1	799.0	1,828.1	47	32	79
1915.....	967.7	715.2	1,682.9	43	23	66
1916.....	1,006.3	755.9	1,762.2	39	20	59
	1,055.1	436.3	1,501.4	43	14	57

<sup>1</sup> No records.<sup>2</sup> Figures taken from a memorandum of superintendent of schools, dated November, 1906, file 7383-1. Old C. A. Dept. Ex. Office.<sup>3</sup> Figures taken from annual report of superintendent of schools to chief of bureau of municipalities, July 25, 1906.<sup>4</sup> Figures taken from printed annual report of Isthmian Canal Commission for 1907. White and colored not shown separately.

Reduced attendance in colored schools for 1916 due to rule excluding children of nonresident alien employees from free school privileges.

TABLE NO. 61.—*Monthly enrollment and average daily attendance.*

	White schools.			Colored schools.		
	Monthly enroll- ment.		Average daily at- tendance.	Monthly enroll- ment.		Average daily at- tendance.
	Gross.	Net.		Gross.	Net.	
1915.						
October.....	1,229	1,176	1,096.7	449	447	342.4
November.....	1,347	1,226	1,092.3	739	551	418.0
December.....	1,375	1,240	1,085.8	796	570	429.3
1916.						
January.....	1,441	1,279	1,087.0	894	658	459.1
February.....	1,488	1,299	1,092.5	940	702	481.6
March.....	1,549	1,328	1,105.6	960	735	466.2
April.....	1,574	1,344	1,097.5	1,017	757	470.8
May.....	1,600	1,357	1,060.5	1,039	775	441.8
June.....	1,609	1,366	1,005.7	1,047	783	437.2

TABLE NO. 62.—*Enrollment for the year, by schools.*

	Gross.	Net.		Gross.	Net.
WHITE SCHOOLS.			COLORED SCHOOLS.		
Balboa High.....	104	104	La Boca.....	259	196
Cristobal High.....	31	30	Paraiso.....	170	148
Grades:			Empire.....	120	86
Ancon.....	294	257	Gatun.....	347	236
Balboa.....	476	350	Cristobal.....	151	117
Corozal <sup>1</sup> .....	23	23			
Pedro Miguel.....	103	86	Total.....	1,047	783
Paraiso.....	37	37			
Empire.....	68	66	Total white.....	1,609	1,366
Gatun.....	136	120	Total colored.....	1,047	783
Cristobal.....	236	207			
Colon Beach.....	101	86	Total.....	2,656	2,149
Total.....	1,609	1,366			

<sup>1</sup> Corozal white school closed Nov. 19, 1915, and pupils transferred to Balboa.

TABLE NO. 63.—*Enrollment by grades (net).*

	White schools.	Colored schools.	Total.
Grade 1.....	254	384	638
Grade 2.....	204	119	323
Grade 3.....	185	103	288
Grade 4.....	142	103	245
Grade 5.....	135	46	181
Grade 6.....	134	16	150
Grade 7.....	99	4	103
Grade 8.....	79	8	87
Grade 9.....	57		57
Grade 10.....	37		37
Grade 11.....	25		25
Grade 12.....	115		115
Total.....	1,366	783	2,149

<sup>1</sup> One pupil who was enrolled in grade 11 made up extra work and was able to graduate.

TABLE NO. 64.—*Number of teachers employed in schools.*

	White schools.	Colored schools.	Total.
1915.			
October.....	42	13	55
November.....	42	13	55
December.....	43	14	57
1916.			
January.....	43	14	57
February.....	43	14	57
March.....	43	14	57
April.....	43	14	57
May.....	43	14	57
June.....	43	14	57

TABLE NO. 65.—*Sickness of teachers.*

	Number of days.		
	White teachers.	Colored teachers.	Total.
1915.			
October.....	8.5	.....	8.5
November.....	2.0	.....	2.0
December.....	13.5	.....	13.5
1916.			
January.....	13.5	.....	13.5
February.....	25.0	1.0	26.0
March.....	16.0	.....	16.0
April.....	31.5	.....	31.5
May.....	36.0	.....	36.0
June.....	14.0	.5	14.5
Total.....	160.0	1.5	161.5
Compared with the school year 1914-15.....	214.0	3.0	217.0

TABLE NO. 66.—*Teachers employed at close of school.*

## WHITE SCHOOLS.

Balboa High School.....	6	Grades—Continued.	
Cristobal High School.....	2	Gatun.....	4
Grades:		Cristobal.....	5
Ancon.....	6	Colon Beach.....	2
Balboa.....	9	Line teachers.....	2
Pedro Miguel.....	3	Spanish teacher.....	1
Paraiso.....	1	Total.....	43
Empire.....	2		

One supervisor of industrial training and one brake attendant also employed.

## COLORED SCHOOLS.

La Boca.....	4	Gatun.....	4
Paraiso.....	2	Cristobal.....	2
Empire.....	2	Total.....	14

TABLE NO. 67.—*Extra substitute teachers employed.*

Extra substitute teachers were employed and paid by voucher at the rate of \$3 a day, as follows:

Month.	Number of days.	Month.	Number of days.
1915.		1916.	
October.....	.....	March.....	.....
November.....	5	April.....	3
December.....	.....	May.....	5
1916.		June.....	.....
January.....	.....		13
February.....	.....		

<sup>1</sup> Compared with 171 days during the school year ended June 30, 1915.

TABLE NO. 68.—*Schoolrooms closed.*

Rooms in schools were closed because of sickness of teachers and inability to provide substitute teachers as follows:

	White schools.	Colored schools.	Total.
1915.			
October.....	2.5		<i>Days.</i> 2.5
November.....	1.5		1.5
December.....	2.5		2.5
1916.			
January.....			
February.....	6.5	1.0	7.5
March.....	3.0		3.0
April.....	9.0		9.0
May.....	5.5		5.5
June.....	8.0	.5	8.5
Total.....	38.5	1.5	40.0
Compared with the school year 1914-15.....	34.0	3.0	37.0

TABLE NO. 69.—*Report of annual physical examination of white grade-school children during October, 1915.*

Number of physical examinations made.....	1,002
Number found needing treatment.....	676
Number with other defects than those of teeth only.....	410
Number with defects of teeth as only defects.....	266
Percentage of those examined needing treatment.....	67
Defects found:	
Defective vision.....	97
Defective hearing.....	22
Defective nasal breathing.....	58
Hypertrophied tonsils.....	240
Pulmonary disease.....	32
Cardiac disease.....	20
Chorea or other nervous disorders.....	5
Orthopedic defects.....	13
Malnutrition.....	14
Defective teeth.....	430
Contagious diseases.....	2
	<hr/> 933
Number of cases treated.....	261

TABLE NO. 70.—*Money received during the year on account of sale of textbooks, etc., and tuition, and turned in to the collector, The Panama Canal.*

	Tuition.	Books and supplies.	Total.
1915.			
July.....		\$35.02	\$35.02
August.....		17.29	17.29
September.....		6.10	6.10
October.....	\$243.00	11.58	254.58
November.....	283.00	17.62	300.62
December.....	265.25	33.41	298.66
1916.			
January.....	235.00	31.49	326.49
February.....	304.77	17.32	322.09
March.....	314.30	26.72	341.02
April.....	283.00	31.53	317.53
May.....	292.00	63.60	255.60
June.....	279.00	101.99	380.99
Total.....	2,532.32	396.67	2,958.99
Compared with the year ended June 30, 1915.....	1,184.00	168.12	1,352.12



TABLE NO. 71.—*Supervisory visits by superintendent, shown by months.*

	Number of days of school.	Number of visits.		
		White schools.	Colored schools.	Total.
1915.				
October.....	20	18	5	23
November.....	19	18	8	26
December.....	13	11	5	16
1916.				
January.....	21	18	8	26
February.....	20	14	7	21
March.....	23	21	10	31
April.....	15	19	8	27
May.....	22	16	8	24
June.....	19	11	6	17
Total.....	172	146	65	211

Average number of supervisory visits daily, 1.23.

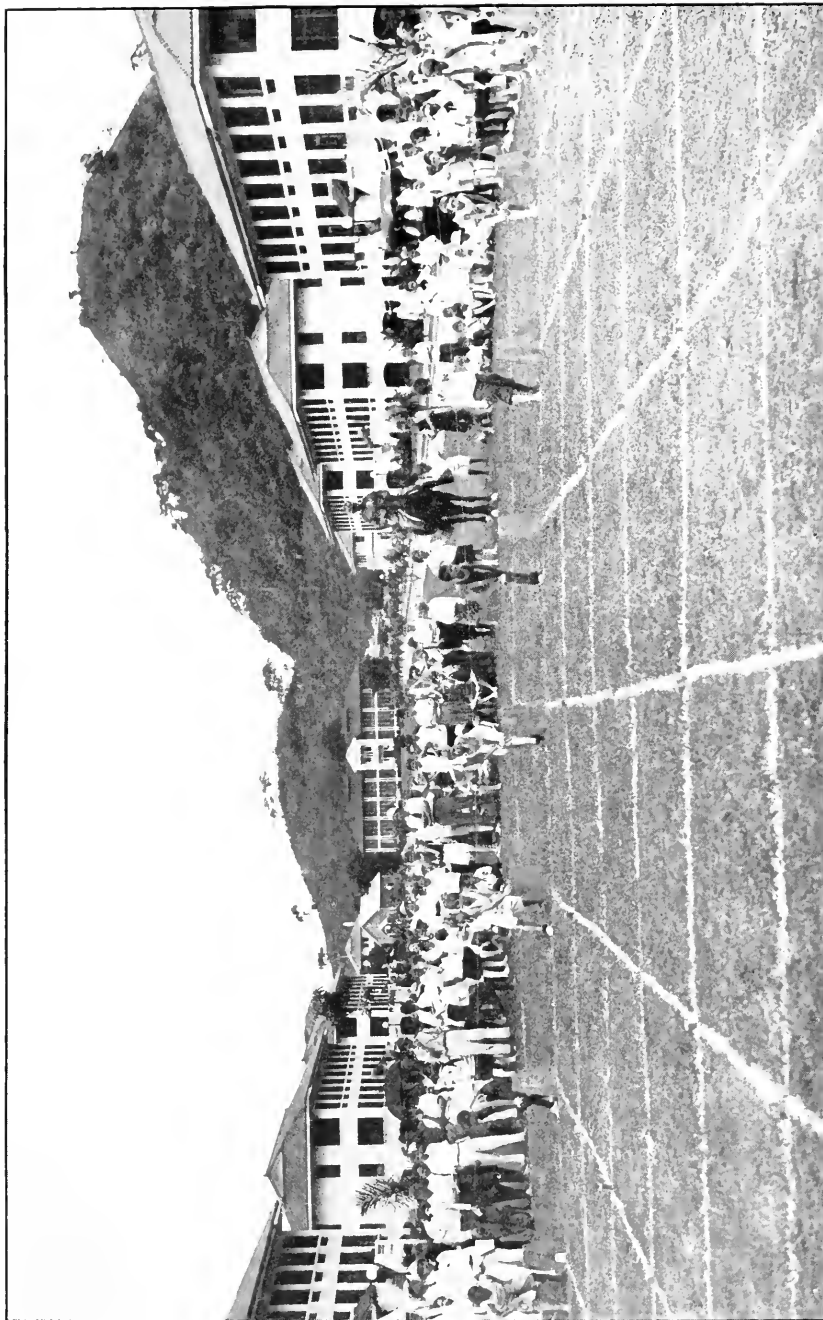
TABLE NO. 72.—*Epitome of more important school statistics for the years ending June 30, 1913, 1914, 1915, and 1916.*

	1913	1914	1915	1916
Number of school buildings.....	29	23	15	16
Buildings erected and converted.....	1	1	4	1
Additional rooms constructed (additions to existing buildings).....	3	4	2	14
Number of employees in division.....	86	75	65	60
Number of supervisory force.....	3	3	1	1
Total expenditures (approximate).....	\$30,000	\$89,000	<sup>2</sup> \$109,000	\$70,188.56
Estimated value of school property.....	\$150,000	\$130,000	\$120,000	\$110,000
Net enrollment:				
White schools.....	1,369	1,270	1,146	1,366
Colored schools.....	1,580	1,492	1,430	783
White and colored.....	2,949	2,762	2,576	2,149
Per capita expense of maintenance (approximate) based on net enrollment.....	\$35.19	\$32.22	<sup>2</sup> \$42.31	\$32.66
Total days of attendance.....	324,282.5	277,016.5	283,988.5	258,244
White schools.....	177,615.5	160,017.5	157,537.0	183,206
Colored schools.....	146,667.0	116,999.0	126,451.5	75,038
Average daily attendance.....	1,828.1	1,682.9	1,762.2	1,501.4
White schools.....	1,029.1	967.7	1,006.3	1,065.1
Colored schools.....	799.0	715.2	755.9	436.3
Absence of teachers on account of sickness.....days..	322	213	217	161.5
Average monthly wages of teachers:				
White.....	\$98.08	\$98.37	\$98.78	\$98.84
Colored.....	\$55.80	\$56.96	\$59.75	\$60.55
Tuition collected.....	\$744.00	\$1,089.00	\$1,184.00	\$2,562.32

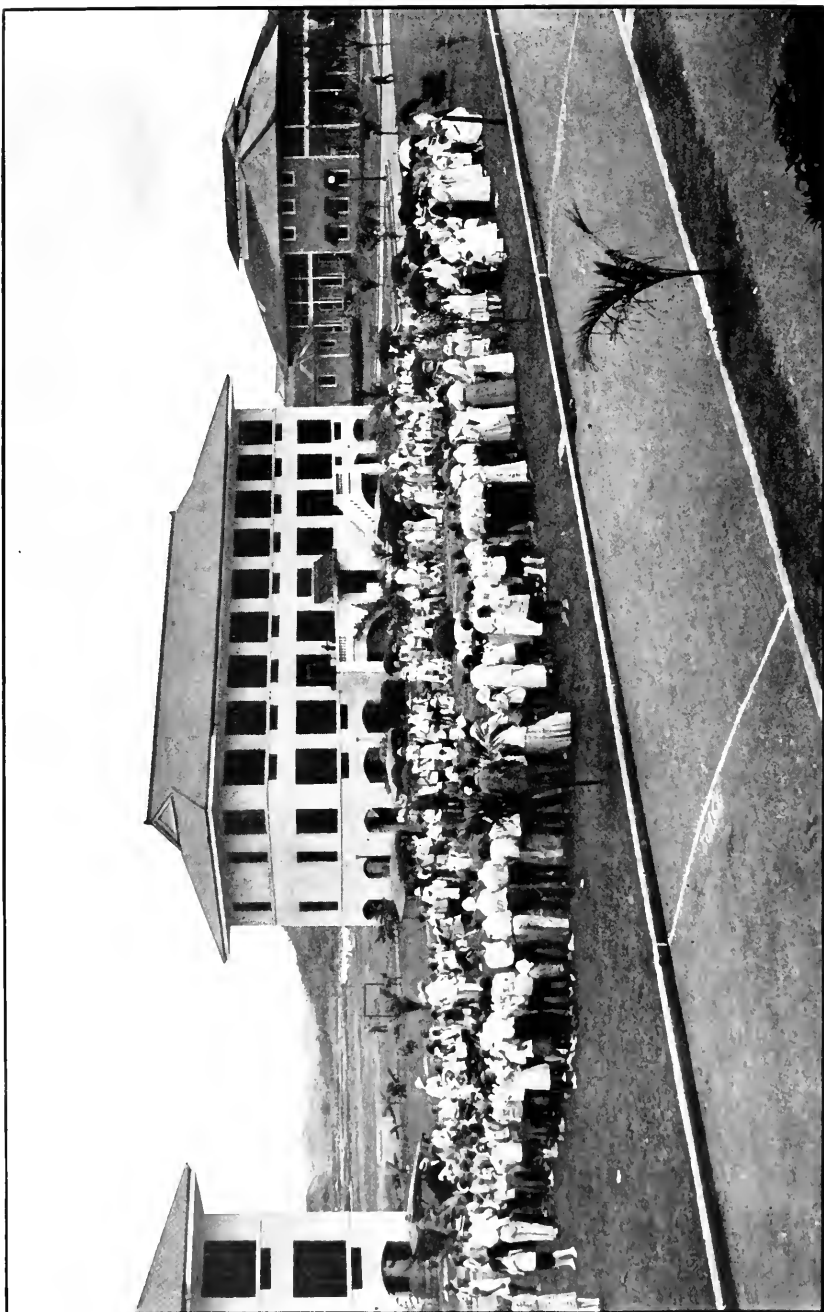
<sup>1</sup> Four-room Ancon colored school building moved to Balboa and reerected as an annex to the Balboa white school.<sup>2</sup> Increase in expenditures due to erection of school buildings at Balboa, La Boca, and Gatun.

Holidays: Panama Independence Day, Nov. 3; Thanksgiving Day and Friday following, Nov. 25 and 26; Christmas holidays, Dec. 18, 1915, to Jan. 2, 1916, inclusive; Washington's Birthday, Feb. 22; Easter holidays, Apr. 15, 1916, to Apr. 23, 1916, inclusive; Memorial Day, May 30.





CANAL ZONE GRAMMAR SCHOOL FIELD AND ATHLETIC MEET, BALBOA. MAY 27, 1916.



CANAL ZONE GRAMMAR SCHOOL FIELD AND ATHLETIC MEET, BALBOA. MAY 27, 1916,

## APPENDIX J.

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### REPORT OF THE DISTRICT ATTORNEY FOR THE CANAL ZONE.

ANCON, CANAL ZONE, *July 1, 1916.*

SIR: I attach hereto in tabulated form a statement of all criminal prosecutions by this office in the district court of the Canal Zone for the fiscal year ending June 30, 1916. There was a total of 427 cases disposed of in the district court, 120 of which were appealed cases from the magistrates' courts.

Of the total number disposed of in the district court, 304 resulted in convictions.

Sentence of the court was suspended in 35 cases, 20 of which were felonies and 15 misdemeanors.

At the end of the fiscal year there were pending 14 criminal cases in the district court, all of which had arisen since the last court day in June.

There have been no appeals in criminal cases to the Circuit Court of Appeals of the Fifth Circuit of the United States, which has appellate jurisdiction over all criminal cases wherein the offense charged is punishable as a felony.

For comparison a summary is given of criminal cases for the fiscal years 1914-15 and 1915-16. This shows a considerable increase in the number of criminal cases, although there has been no corresponding increase in the population of the Canal Zone.

The results of jury trials continue to be unsatisfactory, particularly with reference to white American defendants. Since the Executive order of July 4, 1913, authorizing jury trials in all felony cases, no white American has been found guilty when tried by a jury. This failure to convict is not due to lack of evidence or conflict of evidence. The evidence in many of the cases has been convincing, but the jurors are unwilling to convict and do not seem inclined to accept any responsibility for the enforcement of the laws of the Canal Zone.

I renew the several recommendations heretofore made that the Executive order be so amended as to permit jury trials only in capital cases.

There have been no suits against the Governor of The Panama Canal under the Panama Canal act for injuries to vessels, etc., while passing through the canal locks. A claim for damages to a vessel in another part of the canal was submitted, but the non-liability for the damages, under the circumstances, was clearly indicated and the claim has not been pressed.

Two civil cases of sufficient importance to be noted were disposed of during the year. One was a suit for \$10,000 damages by Madeline B. Holden *v.* Charles G. Morton, colonel, commanding the Fifth Infantry at Empire. The suit was for slander and false arrest, and

arose from the detention of the plaintiff in an effort by Col. Morton to prevent the sale of liquor to the men under his command. The case was tried before a jury in the Balboa division of the district court and resulted in a verdict in favor of the defendant.

The other was the case of *C. P. Fairman v. Ruben Arcia*. This was an attempt by the plaintiff, an attorney at law, to recover fees from the defendant for whom he had filed a claim before the Joint Land Commission and a private settlement had been agreed upon between Arcia and the United States Government in settlement of the claim. An attachment was sued out by the plaintiff and levied upon lands formerly belonging to the defendant, being the same lands involved in the claim before the Joint Land Commission. The claim of the plaintiff was that title to the lands had not passed to the United States prior to the levy of the attachment. The district attorney filed a pleading in the nature of a suggestion to the court that the property levied upon was the property of the United States and that the title had passed to the United States by virtue of the Panama Canal act and the Executive order of December 5, 1912. The case was heard in the Cristobal division of the district court, and upon argument the court reserved its decision. Shortly afterwards and prior to the time fixed for the decision of the court the plaintiff dismissed his attachment.

At the close of the fiscal year there were pending two cases of importance which had been filed some months prior, but which up to that time could not be brought to trial. They were both cases in which a mandamus was sought against the auditor of The Panama Canal. The first suit was brought by Judge William H. Jackson, judge of the district court of the Canal Zone, to compel the auditor of The Panama Canal to pay to him the sum of some \$1,100 on account of the refusal of the auditor to approve for payment pay certificates for the monthly salary of the judge. The Comptroller of the Treasury had decided in several written opinions that Judge Jackson was not entitled to quarters and electric-light service free, nor to more than six weeks' annual vacation, by reason of the provisions of the Panama Canal act of August 24, 1912, to the effect that the district judge, district attorney, and the marshal of the Canal Zone should not receive any emoluments other than their salaries, and also providing that the district judge should be entitled to an annual vacation of six weeks. Just before the close of the fiscal year the President of the United States had designated Judge Henry D. Clayton, of the Middle and Northern District of Alabama, to try the case.

The other mandamus was sought by a clerk upon the silver roll, for the payment of his monthly wages, which had been deducted from to pay for commissary coupon books, and who through a failure to observe the rules relating thereto had negligently allowed the books to be stolen by another clerk.

There are also now pending in the Supreme Court of the United States two very important cases which have been consolidated and will be heard at the coming term of the Supreme Court. The cases are *Gideon Dixon et al. v. George W. Goethals et al.*, and *Samuel Anderson et al. v. George W. Goethals et al.* They are bills for injunctions against the Governor of The Panama Canal and other officials, seeking to prevent the taking over of certain land and the destruction of the houses thereon for the purposes of The Panama Canal. The

complainants in the bills sought the injunctions mainly upon the ground that their property could not be taken prior to the payment of compensation therefor. At the time they applied for the injunctions they had already filed claims before the Joint Land Commission for the property involved, and their claims were awaiting a hearing before the Joint Land Commission in their regular order. The suits were tried in the district court during the incumbency of the former district attorney, Mr. William K. Jackson. Injunction was denied by the district court and an appeal was taken to the Circuit Court of Appeals in New Orleans, and there the appeal was dismissed. Mr. Jackson represented the Government in the Circuit Court of Appeals. The causes have been appealed to the Supreme Court of the United States, and the Government will be represented in that court by the Department of Justice at Washington.

A question of some importance to the district attorney's office arose out of the refusal of the district judge to permit the appearance on behalf of the Government of an assistant to the district attorney who had been appointed for that purpose by the Governor of The Panama Canal. The district judge gave as his reason that the Governor of The Panama Canal under the Panama Canal act had no authority to make the appointment. This matter has been referred to the Attorney General of the United States for his opinion, which had not been received at the close of the fiscal year.

Respectfully,

CHARLES R. WILLIAMS,  
*District Attorney.*

Maj. Gen. GEO. W. GOETHALS, United States Army,  
*Governor, The Panama Canal, Balboa Heights, Canal Zone.*

TABLE NO. 1.—*Criminal prosecutions, 1915-16.*

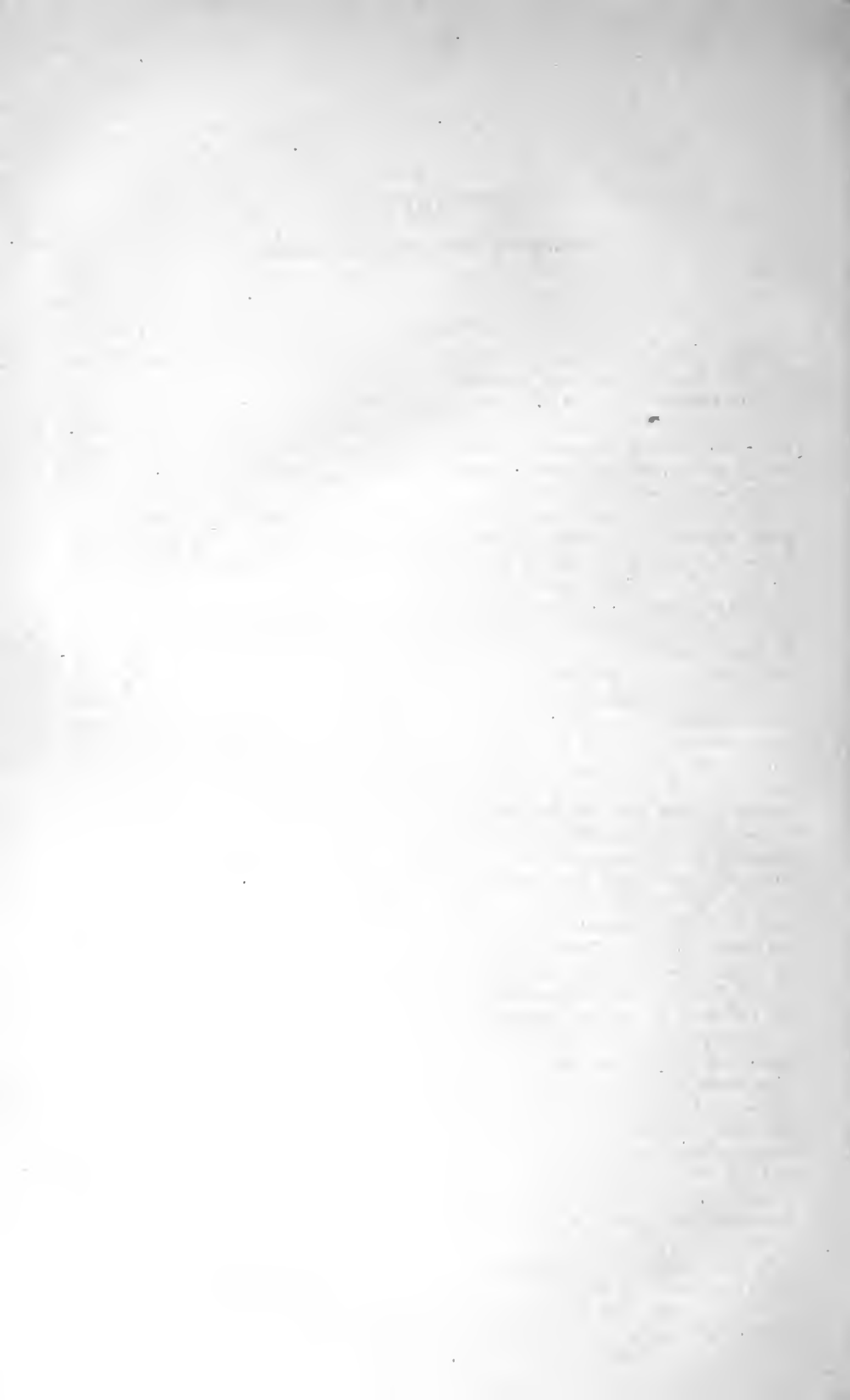
	Num-ber.	Guilty.	Not guilty.	Disposed of otherwise.	Remarks.
Arson.....	1	1	1		
Assault and battery.....	6	4	1	1 appeal with- drawn.	
Assault with deadly weapon.....	12	9	3		3 guilty of assault; 1 guilty of assault and battery.
Assault with means and force likely to pro- duce great bodily harm.....	1	1	1		
Automobile regulations, violation of.....	20	19	1		
Battery.....	16	13	1	2 nol. pros.	1 guilty of assault and battery.
Bigamy.....	1	1			
Bribery.....	1	1			
Bringing stolen property into Canal Zone.....	4	2	1	1 nol. pros.....	
Burglary.....	21	14	6	do.....	10 first degree, 7 second degree, 4.
Burglary, attempt to commit.....	1	1			
Carrying concealed weapons.....	2	2			
Coach tariff regulations, violation of.....	2	1	1		
Conspiracy.....	4		4		
Conspiring to defraud.....	2	1	1		Dismissed on new trial.
Customs regulations, violation of.....	7	5	1	1 nol. pros.....	
Cruelty to animals.....	2	2			
Defraud, attempt to.....	3		2	1 nol. pros.	
Defrauding by false representation.....	1	1			
Deportation, returning to Canal Zone.....	4	4			
Disorderly conduct.....	26	21	1	4 nol. pros.....	
Disturbing the peace.....	1	1			
Drunk.....	1	1			
Drunk and disorderly.....	1		1		
Embezzlement.....	7	5	2		
Escaping from prison.....	1	1			
Extortion.....	1	1			
False personation.....	2	2			
Fighting.....	2	2			
Forgery.....	24	8	16		
Fraud.....	5	2	1	2 nol. pros.....	
Fugitive from justice.....	3	2		1 nol. pros.....	
Grand larceny.....	67	51	11	5 nol. pros.....	21 guilty of petit larceny.
Grand larceny, attempt to commit.....	1		1		
Indecent exposure.....	1		1		
Infamous crime against nature.....	7	2	3	2 nol. pros.....	
Libel.....	1	1			
Liquor regulations, violation of.....	3	3			
Loitering.....	24	20	4		
Lottery laws, violation of.....	5	5			
Malicious mischief to railroad.....	1	1			
Mayhem.....	2	2			
Murder.....	3	2	1		1 second degree; 1 assault with deadly weapon.
Mutiny.....	1	1			
Navigation rules, violation of.....	18	15	1	1 nol. pros., 1 fugitive.	
Nonsupport.....	1	1			
Obtaining money under false pretenses.....	15	8	7		Dismissed on new trial.
Obtain money under false pretenses, at- tempt to.....	1		1		
Opium act, violation of.....	38	30	7	1 nol. pros.....	
Perjury.....	3		3		
Petit larceny.....	23	11	5	7 nol. pros.....	
Petit larceny, attempt to commit.....	1	1			
Postal laws, violation of.....	4	3	1		
Quarantine regulations, violation of.....	3	3			
Rape.....	2	2			1 guilty assisting to commit.
Receiving stolen property.....	2	2			
Resisting an officer.....	1	1			
Revised statute 4596, violation of.....	2	2			
Vagrancy.....	12	11		1 nol. pros.....	
Total.....	427	304	91	32	

Two applications for writ of habeas corpus denied.



TABLE NO. 2.—*Summary of criminal prosecutions for the fiscal years 1915 and 1916.*

	1914-15	1915-16
Adultery.....	4	1
Arson.....	2	6
Assault and battery.....	22	12
Assault with deadly weapon.....	1	1
Assault with intent to commit murder.....	1	1
Assault with intent to commit felonies other than murder.....	1	1
Assault with means and force likely to produce great bodily harm.....	1	1
Attempt to kill by poison.....	1	1
Automobile regulations, violation of.....	1	20
Battery.....	5	16
Bigamy.....	1	1
Bribery.....	1	1
Bringing stolen property into Canal Zone.....	5	4
Burglary.....	39	21
Burglary, attempt to commit.....	1	1
Buying Government property from a soldier.....	2	2
Carrying concealed weapons.....	5	2
Coach tariff regulations, violation of.....	4	2
Conspiracy.....	5	4
Conspiring to defraud.....	1	2
Customs regulations, violation of.....	2	7
Cruelty to animals.....	2	2
Defraud, attempt to.....	2	3
Defrauding.....	1	1
Defrauding by false representation.....	7	4
Deportation, returning to Canal Zone.....	1	1
Deserter.....	22	26
Disorderly conduct.....	1	1
Disturbing the peace.....	1	1
Drunk and disorderly.....	20	7
Embezzlement.....	1	1
Escaping from prison.....	1	1
Extortion.....	1	2
Falsifying evidence.....	4	2
False personation.....	9	24
Fighting.....	5	5
Forgery.....	2	3
Fraud.....	27	1
Fugitive from justice.....	87	67
Gambling.....	1	1
Grand larceny.....	2	1
Grand larceny, attempt to commit.....	1	1
Immigration laws, violation of.....	2	1
Indecent exposure.....	2	7
Infamous crime against nature.....	1	1
Intoxication.....	1	1
Libel.....	7	3
Liquor regulations, violation of.....	17	24
Loitering.....	2	5
Lottery laws, violation of.....	2	1
Malicious mischief.....	3	2
Malicious mischief to railroad.....	3	3
Manslaughter.....	3	1
Mayhem.....	3	2
Murder.....	3	3
Mutiny.....	3	1
Navigation rules, violation of.....	2	18
Nonsupport.....	3	1
Obtaining money under false pretenses.....	3	15
Obtain money under false pretenses, attempt to.....	9	1
Opium act, violation of.....	1	38
Perjury.....	11	3
Petit larceny.....	1	23
Petit larceny, attempt to commit.....	1	1
Postal laws, violation of.....	10	4
Quarantine regulations, violation of.....	2	3
Rape.....	2	2
Rape, attempt to commit.....	2	2
Receiving stolen property.....	1	1
Resisting an officer.....	1	2
Revised Statutes 4596, violation of.....	5	1
Robbery.....	1	1
Sanitary regulations, violation of.....	1	1
Speed regulations, violation of.....	10	12
Vagrancy.....	1	1
White slave act, violation of.....	391	427
Total.....		



## APPENDIX K.

### REPORT OF SPECIAL ATTORNEY.

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ANCON, CANAL ZONE, *August 14, 1916.*

SIR: I have the honor to submit the following report on the affairs of this office for the fiscal year ended June 30, 1916:

The organization of the special attorney's office remains the same as it was at the beginning of the fiscal year just ended, except that the number of land inspectors was reduced to two at the latter end of the year, on account of the decrease in the number of land claims remaining unsettled.

The only Executive order prepared in this office during the fiscal year was that of October 16, 1915, which provides for an annual recess for the Joint Land Commission, appointed under Articles VI and XV of the Panama Canal treaty.

The existing Executive orders need revision, in order to adapt them to the new conditions created by the change from canal construction to canal operation, and especially because of the large military establishment that has been located here; but the ruling of the Attorney General, that the President is without power to revise the orders issued prior to the passage of the Panama Canal act prevents any modifications of the preexisting laws by Presidential order, but efforts have been made to obtain relief from Congress. Bills were drafted in this office for submission to that body, providing amendments to the existing road laws; the laws relating to the licensing of motor vehicles; the police and sanitary regulations, including those relating to quarantine; and the laws relating to taxation. Most of these subjects have been incorporated in a bill presented to Congress by Mr. Adamson, chairman of the House Committee on Interstate and Foreign Commerce, which committee has jurisdiction of canal matters. Mr. Adamson's bill (H. R. 15955), passed the House weeks ago, and cable information was received on the Isthmus on August 5 that the Senate had passed the bill with amendments; and, no doubt, the bill will be duly enacted at this session of Congress.

During the last fiscal year, the land office has settled by private agreement and paid 586 claims, aggregating the sum of \$335,740.50. This amount includes the large claim settled with Gov. Reuben S. Arcia, of Colon, for his Rio Indio and Mindi land and improvements thereon, for the sum of \$95,000. Several other large claims were settled during the fiscal year. This makes the total number of claims settled and paid since the work of clearing the Canal Zone was commenced on January 1, 1913, 4,182, aggregating the sum of \$851,566.64, exclusive of any award made by the Joint Land Commission.

A grand total of 5,244 claims, aggregating a sum of \$1,100,469.94, have been settled and paid through the law department since August 1, 1908, when that department was authorized by Executive order to handle matters relating to land claims.

The Joint Land Commission, appointed under Articles VI and XV of the Panama Canal treaty, made 18 awards during the last fiscal year. These awards involved 27 claims, some of the claimants having more than one claim before the commission. The 18 awards aggregate the sum of \$10,675.

The commission dismissed 854 claims on account of previous payment having been made by the land office to the claimants, and 16 claims were dismissed by the commission on account of insufficiency of the evidence. One claim was dismissed at the request of claimant's counsel because the property claimed is not located within the Canal Zone, and one was dismissed for want of jurisdiction. The number of dismissals by the commission during the fiscal year aggregated 872.

The commission disagreed in 15 cases, in 6 of which certificates of disagreement covering 9 docket numbers were perfected and submitted to the umpire during the fiscal year. The umpire rendered 4 decisions during the fiscal year, involving 17 claims, aggregating the sum of \$50,662.

Hence 22 awards were made during the fiscal year by the Joint Land Commission and the umpire, involving 44 claims, aggregating the sum of \$61,337.

Five of the awards made by the commission related to land claims, and 17 for improvements only. The umpire made 2 awards for land claims, and 15 in cases in which improvements only were claimed.

A recast of the Joint Land Commission docket, made by the secretary on July 12, 1916, showed 939 cases then pending, including 1 that was filed in January of this year. Between June 30, 1916, and July 12, 1916, when the new docket was prepared by the secretary of the commission, 81 cases had been disposed of, which should be added to the 939 appearing on the docket of July 12, 1916, making the number of cases pending on the commission docket on June 30, 1916, 1,020. The 1,020 claims appearing on the commission docket of June 30, 1916, aggregate the sum of \$12,308,834.15. There are 39 claims in which no specific amount of money is claimed, and in consequence, their value is not included in the aggregate sum just mentioned.

Admiral Victor Maria Concas y Palau was appointed umpire by the President of the United States and the President of Panama under the provisions of Articles VI and XV of the Panama Canal treaty. He arrived upon the Isthmus on April 10, 1916, and soon thereafter entered upon his duties as such umpire.

On June 30, 1916, there were 32 licenses in effect, which were issued by the land agent for The Panama Canal within the Canal Zone. These licenses included lots occupied by various oil companies for oil tank sites, church lots, and one license for two acres of ground at Porto Bello.

During the fiscal year there were 10 licenses issued for lots within the Canal Zone. These are included in the 32 above mentioned. The total rental collected on the licenses was \$10,918. This is a considerable increase over last year, because of the fact that since January 1, 1916, all rentals from the Mount Hope tank farm have been collected by The Panama Canal instead of the Panama Railroad Company.

In the annual report of this office for the year ended June 30, 1915, reference was made to the suit of Gideon Dixon et al. against George W. Goethals et al. and the case of Samuel Anderson et al. against the same defendants named in the Dixon suit. These suits were brought in the district court at Cristobal to enjoin the Governor of The Panama Canal, the chief of police, the land agent, the Panama Railroad Company, and the local agent of an oil company from taking possession of certain lands at Mount Hope, under the President's order of December 5, 1912. The court declined to issue the injunction, and the cases were consolidated and the plaintiffs appealed to the Circuit Court of New Orleans. The New Orleans court denied the injunction and dismissed the appeal, from which order the two cases were taken by the plaintiffs to the Supreme Court of the United States. They attempted to obtain a temporary restraining order from the Court at Washington, which was denied them. The cases have not been reached upon the trial docket of the Supreme Court. Inasmuch as that court denied a temporary restraining order, the Canal Zone authorities proceeded to take possession of the property involved, and to remove the structures therefrom that were interfering with the construction work of The Panama Canal.

There was a slight increase in the amount of land rentals by the Panama Railroad Company in the cities of Panama and Colon as of June 30, 1916. This was due to the fact that the Railroad Company leased a few additional lots in Colon during the past fiscal year, particularly in that area known as the "manufacturing district." There is but slight chance that these rentals will be further increased, as the railroad company has leased about all of its available building lots in Colon. If it is desired to permit the further growth of the city it will be necessary for the railroad company to grade, either by dry or hydraulic fill, an additional piece of land to the east of G Street. At the present time the land agent has only three or four lots unleased, which will no doubt be taken in the near future.

There has been no change in the condition of the leases for Panama Railroad Company lots at Folks River, although in all probability all of the leases of lots there will be canceled in pursuance of the President's depopulation order.

On April 30, 1916, all leases for building lots at Monte Lirio were canceled, thereby decreasing the land rental revenues of the company by \$396. The cancellation of these leases was effected in accordance with the general order of depopulation. Consequently the only property which the Panama Railroad is now leasing within the Canal Zone are the few lots at Folks River.

A slight decrease appears in the rental of Panama Railroad property at Panama. This is due to the cancellation of the leases held by Pinel & Co. for the English wharf. The cancellation of these leases necessitated the termination of two other leases for property in the vicinity of the English wharf. The amount of revenue lost is small, being only \$275 per annum. The cancellation of the lease of the English wharf was due to its condemnation, as well as that of the American wharf, by the health officer of Panama.

The total of all leases, licenses, and permissions in effect for all Panama Railroad property on June 30, 1916, was 1,279, covering 1,380 lots, earning an annual rental of \$129,415.88, assuming that all

of the rental is collected. This is the rental value as taken from the book records as of June 30, 1916. It will thus be seen that the rental values accruing to the railroad company are \$8,569.10 more than the rentals of the previous fiscal year.

The total amount of money actually collected from all Panama Railroad properties occupied under leases, licenses, and permissions during the present fiscal year, as per statement submitted to the land agent by the Panama Railroad accountant, is \$132,467.54, an increase of \$19,917.31 over the actual collections for the fiscal year ended June 30, 1915. In addition, the rentals to be collected for the fiscal year ending June 30, 1917, assuming that they will all be collected, will show an increase of about \$9,000 over the book-account rentals of the previous fiscal year. These increases have been made in spite of the fact that since June 30, 1914, the company has lost nearly \$26,000 per annum, due to the cancellation of Canal Zone leases at Gatun, Monte Lirio, Frijoles, Empire, and Culebra. In addition, the railroad company's land rentals have been decreased \$6,600, due to the fact that all rentals derived from the licensing of lots at the Mount Hope oil-tank farm have been collected for the account of The Panama Canal since January 1, 1916, this being done because all lands of the Panama Railroad Company in the Canal Zone have been taken over by the Government of the United States for the construction, operation, maintenance, sanitation, and protection of The Panama Canal. Consequently all licenses for oil-tank lots at Mount Hope will now be issued by the land agent, acting on behalf of The Panama Canal, and not the Panama Railroad Company.

During the past fiscal year there were 95 new leases executed for 113 lots, and 16 new leases issued for 18 half lots, on behalf of the Panama Railroad Company in the cities of Colon and Panama. Some of these leases were renewals and others were for lots previously leased to parties who failed to comply with the terms of their lease; and consequently the termination of the lease was effected, after which lots were advertised and leased to other parties.

I am submitting a statement of Panama Railroad leases and licenses in effect July 1, 1916, prepared by the land agent:

*Statement of Panama Railroad leases and licenses in effect July 1, 1916.*

Location.	Leases.		Lots.		Rental.	
	July 1, 1915.	July 1, 1916.	July 1, 1915.	July 1, 1916.	July 1, 1915.	July 1, 1916.
Colon.....	771	794	781	819	\$76,538.48	\$82,885.80
Folks River, R. P.....	53	53	55	55	2,364.40	2,364.40
Folks River, C. Z.....	17	17	16	16	1,264.20	1,264.20
Stable lots (Colon).....	10	9	11	12	672.00	576.00
Monte Lirio.....	10	.....	14	.....	396.00	.....
Las Esplanadas.....	106	105	127	121	3,982.50	4,010.00
Guachapali.....	151	153	193	195	7,910.96	8,154.16
Santa Cruz.....	83	88	103	106½	3,353.04	3,977.08
Panama Yard <sup>2</sup> .....	18	17	30	29½	3,362.00	4,350.00
Juan Ponce.....	1	1	1	1	60.00	60.00
English Wharf.....	33	.....	3	.....	275.00	.....
Total for leases.....	1,223	1,237	1,337	1,353	100,178.58	107,612.21

<sup>1</sup> Canceled Apr. 30, 1916.

<sup>2</sup> Increase in rental for Panama yard due on account of \$1,000 increase in rental of land leased to Panama Brewing & Refrigerating Co.

<sup>3</sup> Canceled Apr. 8, 1916.

*Statement of Panama Railroad leases and licenses in effect July 1, 1916—Continued.*

Location.	Licenses and permissions.		Lots.		Rental.	
	July 1, 1915.	July 1, 1916.	July 1, 1915.	July 1, 1916.	July 1, 1915.	July 1, 1916.
Miscellaneous (Colon) <sup>1</sup> .....	13	8	29	.....	\$1,509.00	\$145.00
Buildings, stores, and rooms in Colon .....	10	15	.....	.....	8,734.20	15,949.64
News agency.....	1	1	.....	.....	3,072.00	1,560.00
Cristobal.....	3	3	3	3	1,200.00	1,200.00
Mount Hope.....	5	5	13	13	3,900.00	( <sup>2</sup> )
Huerta Sandoval.....	.....	4	.....	6	.....	666.00
Balboa buildings.....	6	6	.....	.....	2,253.00	2,253.00
Total for licenses and permissions	38	42	45	22	20,668.20	21,773.64
Grand total for all leases, licenses, and permissions.....	1,261	1,279	1,382	1,380	120,816.78	120,415.88

<sup>1</sup> Miscellaneous leases have been included this year with statement regarding licenses and permissions, inasmuch as these are for miscellaneous pieces of land which might be required at any time by the railroad, and, consequently, the occupants of same hold the land more or less under a temporary permission. It will be noted that the amount of miscellaneous permissions has decreased, and this is explained because certain properties are now included with leased lots or come under the heading of buildings, stores, etc. R. S. Carlson, land agent, Ancon, C. Z., July 29, 1916.

<sup>2</sup> All rentals for tank sites collected by Panama Canal effective Jan. 1, 1916.

On July 9, 1916, a fire occurred in the City of Colon, which destroyed a number of houses located upon Panama Railroad lots. The fire covered 14 lots. Reconstruction of houses upon these lots must conform to decree 23, issued by the President of Panama on May 31, 1915, which requires all buildings thereafter to be constructed in the City of Colon to be of masonry, brick, concrete, or other fireproof material. A circular letter has been issued by the land agent to the lessees of lots in the burned area, informing them that the railroad company is willing to grant them new leases for a period of 25 years from July 1, 1915, instead of the 15-year lease held by the lessees, provided the lessees will accept the new leases with a change in article 10 of the existing leases. As amended, the article will provide that at any time prior to the expiration of the lease period, should the Government of the United States or the Panama Railroad Company have need of the leased lots, the lessor company shall have the privilege of terminating the lease upon one year's notice in writing upon the payment at that time of the fair and reasonable value of any buildings constructed on the property.

The existing leases do not contain provision authorizing the railroad company to terminate them upon notice. Since the circular letter was issued by the land agent six new leases covering eight lots have been issued to the lessees in the burned area. I might add that the new form of lease had already been issued to the lessees of lots in the area covered by the previous fire of April 30, 1915.

The following Panama Railroad cases were settled, either by judgment or compromise, during the fiscal year 1915-16:

## CRISTOBAL DIVISION, DISTRICT COURT OF THE CANAL ZONE.

James Beckford v. The Panama Railroad Company, civil case No. 83. This suit was for \$10,000 on account of personal injuries. The complaint was filed on October 13, 1914, and a judgment was rendered by the district court against the Panama

Railroad on October 6, 1915, for the sum of \$2,500 and costs. The case was taken to the Circuit Court of Appeals at New Orleans by counsel for the railroad on appeal as well by writ of error. The appellate court dismissed the appeal and affirmed the judgment of the trial court on the writ of error proceedings. The judgment and costs were satisfied by the Panama Railroad Company on May 20, 1916.

*Fenne Coverley v. The Panama Railroad Company*, civil No. 66. This suit was for \$10,000 for personal injuries. Suit was instituted on January 14, 1915, and settlement made May 20, 1916. The plaintiff accepted \$650 in full settlement of the claim.

*Joseph Clark*, as administrator of estate of Catherine Farquharson, deceased *v. The Panama Railroad Company*, civil No. 101. This suit was for \$5,000 for personal injuries resulting in death; filed August 12, 1915; nonsuit entered at plaintiff's request November 6, 1915.

*Joseph Forrest*, by his guardian ad lit., *William C. McIntyre v. The Panama Railroad Company*, civil No. 105. Suit for \$10,000 for personal injuries. Complaint filed September 8, 1915. Case dismissed on plaintiff's motion May 3, 1915.

*Fred Huber v. the Panama Railroad Company*, civil No. 125. Suit for \$750 on account of the wrecking of plaintiff's automobile by one of the company's locomotives. Complaint was filed January 17, 1916. On May 4, 1916, the plaintiff accepted \$300 in full settlement.

*Andres Montpoint*, administrator of the estate of Joseph John, deceased *v. The Panama Railroad Company*. Suit for \$10,000 damages for injuries resulting in death. Case was filed on October 19, 1915. The demurrer filed by the defendant company was sustained and the case dismissed November 19, 1915.

In addition to the cases mentioned above in the district court of Cristobal, the case of *Edward Marsden v. The Panama Railroad Company*, civil No. 224, was filed in the magistrate's court at Cristobal, seeking damages in the sum of \$300 on account of the wrecking of plaintiff's coach by one of the engines of the Panama Railroad. Suit was instituted on September 8, 1915. On September 18, 1915, the plaintiff accepted \$200 in full settlement of the claim.

#### BALBOA DIVISION. DISTRICT COURT OF THE CANAL ZONE.

*Alonzo B. Jones v. The Panama Railroad Company*, civil No. 69. Suit for damages in the sum of \$2,500 for false imprisonment and malicious prosecution. Complaint was filed on July 24, 1915; trial was had and judgment entered for the defendant September 25, 1915.

*William L. Davis v. The Panama Railroad Company*, civil No. 48. Suit for \$500 damages for false imprisonment. Complaint was filed on December 9, 1914, and trial was had on January 29, 1916, resulting in a judgment against the company for the sum of \$300 and costs. Motion for new trial being overruled the judgment was satisfied by the railroad company on April 17, 1916.

*M. J. Solomon v. The Panama Railroad Company*, civil No. 77. Suit for \$27,000 damages for refusal of the railroad company to ship junk belonging to Solomon and for slander. Complaint was filed on September 13, 1915. The trial was had by a jury on January 10, 1916, and a verdict obtained for the plaintiff against the company for \$280 and costs.

The following cases were pending in the courts of the Canal Zone against the Panama Railroad Company at the end of the fiscal year 1915-16:

#### CRISTOBAL DIVISION. DISTRICT COURT OF THE CANAL ZONE.

*Michael Chisholm v. The Panama Railroad Company*, civil No. 134. Suit for \$10,000 damages for personal injuries. Complaint was filed on May 3, 1916, and appearance entered by the railroad company on June 17, 1916.

*James Daley v. The Panama Railroad Company*, civil No. 70. Suit for \$440 debt. Case filed January 30, 1915; answer filed by the railroad company May 27, 1915. No further action has been taken in the case due to the absence of witnesses.

*T. A. Green v. The Panama Railroad Company*, civil No. 97. Suit for \$1,000 damages for killing a horse by an engine of the Panama Railroad Company. This case was filed on July 3, 1915. Demurrers on behalf of the railroad company were presented and overruled, and answer was filed on behalf of the railroad company on October 12, 1915, since which time no further action has been taken in this case.

*George Duncan Gittens v. The Panama Railroad Company*, civil No. 130. Suit for \$10,000 damages for personal injuries. Complaint was filed on March 15, 1915, and demurrer was filed on behalf of the Panama Railroad Company on May 1, 1915, and no action had been taken on this case at the end of the fiscal year.



Leopoldo B. Garcia *v.* the Panama Railroad Company, civil No. 141. Suit for \$3,500 for personal injuries. Complaint was filed on June 16, 1916, and appearance was entered on behalf of the Panama Railroad Company on June 17, 1916.

Daniel Pivott, administrator of estate for Edward C. Pivott, deceased, *v.* The Panama Railroad Company, civil No. 142. Suit for damages for \$20,000 for injuries resulting in death. Complaint was filed on June 30, 1916; since said date an appearance has been entered on behalf of the Panama Railroad Company.

Tomas Reina *v.* Beatriz Bracho et al. and the Panama Railroad Company, civil No. 139. Bill for partition of lands known as "Rio Indio y Mindi." Suit was filed on May 29, 1916. Appearance was entered on behalf of the Panama Railroad Company on June 17, 1916.

All of the lands involved in this case were taken over by the United States under the President's depopulation order prior to the filing of the plaintiff's complaint in the district court, and in consequence the lands were no longer within the reach of the court's jurisdiction. This phase of the case will be urged before the district court by counsel for the Panama Railroad and the United States.

Dudley Smith *v.* The Panama Railroad Company, civil No. 132. Suit for damages for \$2,500 for personal injuries. Complaint was filed on April 17, 1916, and demurrers on behalf of the railroad company to complaint were filed May 1, 1916.

Joseph T. Toppin *v.* The Panama Railroad Company, civil No. 96. Suit for \$15,000 damages on account of personal injuries. Complaint was filed on July 3, 1915, and the demurrers filed on behalf of the Panama Railroad Company were overruled on September 11, 1915, and answer was filed on behalf of the railroad company on October 12, 1915. No further action has been taken on this case since that date.

In addition to the above-mentioned cases pending in the district court at Cristobal on June 30, 1916, against the Panama Railroad Company, there are three other cases that have been on the docket for several years. The cases are:

Panama Railroad Company *v.* Eufracia C. de Villalobos and Porfirio Melendez. Suit for revindication of lands. Petition filed March 21, 1912.

Pedro Celestino Cereso *v.* Eusebio Diaz et al., and the Panama Railroad Company as intervenor. Petition to establish title to real property. Petition filed June 24, 1909.

Panama Railroad Company *v.* A. S. Mendes et al. Suit for recovery of land. Petition was filed March 6, 1912.

The lands involved in the three cases just mentioned have been taken over by the United States under the President's depopulation order; and the parties claiming the property adversely to the Panama Railroad Company have filed their claims before the Joint Land Commission. For that reason no disposition has been made of these cases.

#### BALBOA DIVISION, DISTRICT COURT OF THE CANAL ZONE.

Joseph Marshall *v.* The Panama Railroad Company, civil No. 235, in the magistrate's court. Suit for \$300 damages for injury to a horse by one of the Panama Railroad busses running between the Tivoli Hotel and Balboa. Suit was instituted on May 27, 1916. Trial was had and judgment rendered in favor of the plaintiff in the sum of \$95. The company appealed the case to the District Court of the Canal Zone, Balboa division. This case has been disposed of since June 30, 1916, by judgment against the Panama Railroad Company in the sum of \$50.

Reference is made in the annual report of this office for the year 1914-15 to suit instituted by the Panama Railroad Company against Rodriguez and Uribe in the courts of the Republic of Panama, to prevent the defendants from interfering with the rights of the Company along the shore front in the City of Panama at and adjacent to the American pier, which is the property of the Panama Railroad Company. The second circuit court of the City of Panama rendered a judgment against the Railroad Company on May 3, 1915. An appeal was taken to the Supreme Court of Panama on May 3, 1915, where a preliminary judgment against the Panama Railroad was rendered on May 31, 1915. A motion for reconsideration of the preliminary judgment was denied.

During the last fiscal year the issues between the Panama Railroad Company and the defendants were adjusted by written agreement. The defendants acknowledged the ownership of the Railroad Company

to the pier and shore front adjacent to the pier; that is to say, they acknowledged all of the rights of the Panama Railroad Company. They then entered into an agreement with the railroad company by which the latter was to permit them to use the company's tracks to bring material to the shore front for the purpose of reclaiming a considerable portion of the submerged area. In consideration of the use of the company's tracks Rodriguez and Uribe agreed to fill in the submerged area in front of the railroad company's property. The agreement was carried out by both parties. As a result of this settlement, the Panama Railroad Company retained complete ownership and possession of its shore front adjoining the American pier, and 4,066 square meters of the submerged area in front of its property was reclaimed for its benefit by Rodriguez and Uribe.

In addition to the duties above mentioned, this office has rendered services to the Governor of The Panama Canal in his dealings with the Washington authorities; and this office has also rendered assistance in legal matters to the American Minister in Panama when requested by him.

Respectfully,

FRANK FEUILLE,  
*Special Attorney.*

Maj. Gen. GEO. W. GOETHALS, United States Army,  
*Governor, The Panama Canal, Balboa Heights, Canal Zone.*

## APPENDIX L.

### REPORT OF THE CHIEF HEALTH OFFICER, DEPARTMENT OF HEALTH.

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BALBOA HEIGHTS, CANAL ZONE, *July 22, 1916.*

SIR: I have the honor to submit the following report of the operations of the health department for the fiscal year ending June 30, 1916:

This department was in charge of Lieut. Col. Charles F. Mason as chief health officer for the greater part of the year. He was relieved from duty with The Panama Canal on June 7, 1916, the undersigned assuming the duties of chief health officer on June 22, 1916.

#### GENERAL REMARKS.

No cases of yellow fever, smallpox, or plague have originated on the Isthmus during the year. With the exceptions noted below, no cases of these diseases were brought to the Isthmus during this period.

Four cases of yellow fever were received at Balboa quarantine on the following dates: One case September 27, 1915; 1 case October 25, 1915; 2 cases December 10, 1915. All of these cases came from Buenaventura, Colombia, by the steamship *Jamaica*. Proper precautions were taken and no secondary cases developed. There was no knowledge in the Canal Zone of the existence of yellow fever at Buenaventura until the arrival of the first case, on September 27; bill of health was "clean" as to existence of yellow fever in each instance. This emphasizes the necessity of maintaining a protective quarantine against South and Central American ports.

The average number of employees on the rolls of The Panama Canal, the Panama Railroad, and contractors doing work for The Panama Canal for the year was 33,548, as compared with 37,715 for 1915. The gross cost of the health department for the year was \$933,127.66, as compared with \$923,108.78 for 1915. Increase over the previous year has been due to the large amount of permanent work done in ditching and drainage, necessitated by the location of permanent townsites.

During the year 19,770 persons were vaccinated in the cities of Panama, Colon, the Canal Zone, and on board vessels.

Practically no change has been made in the locations of military units during the year; the greater number continue to occupy the posts on the west side of the canal. The total strength of troops stationed in the Canal Zone on June 30, 1916, was 7,138, as compared with 6,248 on the corresponding date of last year. The number of women and children pertaining to military commands was 869, as compared with 373 for last year. Among the troops there were 4,312 admissions during the year, with 8 deaths. Malaria was given as the cause of admission in 479 cases.

A sanitary commission consisting of Dr. E. P. Beverly and Sanitary Inspector Joseph A. Corrigan, both in the Panama Canal service, proceeded to Buenaventura, Colombia, at the request of the Colombian Government, on March 20, 1916, returning June 28, 1916. They apparently did most excellent work. In their report it is stated that there has been no yellow fever in Buenaventura since May, 1916, but that the work accomplished is of a temporary nature, as with a lack of proper water supply, sewage and drainage systems, and active antimosquito work, this port can not be expected to remain free from the disease.

### VITAL STATISTICS.

#### EMPLOYEES.

The health of employees remained good during the year. The total admission rate to hospitals and quarters was 301.09,<sup>1</sup> compared with 337.21 for 1915. The total admission rate to hospitals only for the year was 164.78, compared with 204.18 for 1915, and for disease alone 125.88, as compared with 156.81 for 1915.

The total death rate for 1916 was 6.65, as compared with 5.78 for 1915, and the death rate for disease 4.98, as against 3.61 for 1915. The noneffective rate for 1916 was 10.08, compared with 10.67 for 1915.

Conditions with regard to malaria are improving steadily each year. The total admission rate for malaria—hospitals and quarters—was 34, as compared with 66.60 for 1915, a reduction of 48 per cent from the rate of the previous year; the constantly noneffective rate, hospitals and quarters, was 0.87, as against 1.29 for 1915. The death rate for malaria was 0.15, as compared with 0.21 for 1915. Only one death from malaria occurred among white employees during the year.

The admission rate for typhoid fever was 0.18, as against 0.19 for 1915; and the death rate 0.12, as compared with 0.03 for 1915.

The admission rate for dysentery was 0.80, as compared with 0.85 for 1915. The death rate for dysentery was 0.09, as compared with 0.05 for the previous year.

The death rate for pneumonia was 1.16, as compared with 0.58 for 1915.

The five diseases causing the highest number of hospital admissions, with their rates, were as follows:

	Number of admis- sions.	Rate.
Malaria.....	983	29.30
Venereal diseases.....	575	17.14
Diseases of the eye and annexa.....	169	5.04
Tuberculosis.....	128	3.81
Influenza.....	99	2.95

<sup>1</sup> All rates are based on the annual rate per 1,000 employees.

The five diseases causing the highest number of deaths, with their rates, were as follows:

	Number of deaths.	Rate.
Lobar pneumonia.....	38	1.13
Tuberculosis.....	31	.92
Nephritis.....	19	.57
Organic disease of the heart.....	15	.45
Apoplexy.....	6	.18

#### EFFECTS OF SEASON.

The highest death rates for disease occurred in the months of April and June, and the lowest in May and July. The highest admission rates for disease were in July and August, and the lowest in April and May.

#### EFFECTS OF RACE.

The admission rate to hospitals and death rate for disease for black employees were 99.01 and 5.25, as compared with 295.23 and 3.26 for white employees. The noneffective rate for disease and injuries for black employees was 8.67, as compared with 18.92 for white employees.

The admission rate to hospitals and quarters for malaria was 25.62 for blacks, as compared with 85.69 for white employees.

#### DEPORTATIONS.

The number of deportations was 69, divided as follows:

	Disease.	Injury.	Total.
Employees.....	33	18	51
Nonemployees.....	18	.....	18
Total.....	51	18	69

#### CANAL ZONE.

The average population of the Canal Zone for the year was 31,384, as compared with 35,249 for last year. There was a total of 398 deaths during the year; of these, 346 were from disease, giving a rate of 11.02, as compared with 11.77 for the year 1915.

The death rate from tuberculosis was 1.21, as compared with 1.33 for the year 1915. Deaths from tuberculosis this year were 9.55 per cent of all deaths.

The birth rate for the year was 20.61. The infant mortality rate for white children under 1 year of age was 89 per thousand, and for colored children 211, with a general average of 170. Total deaths from disease for children under 5 years of age was 41 per cent.

#### PANAMA CITY.

With an average population of the city for the year of 60,576 there was a total of 1,710 deaths, of which 1,652 were from disease, giving a rate of 27.27 per thousand, as compared with 30.74 for the preceding

year. The death rate for malaria was 0.24, as compared with 1.39 for 1915.

There were 2,664 births reported during the year, giving a birth rate of 43.98. The infant mortality for the same period was 212 per thousand.

Of the total deaths from disease, there were 812 deaths under 5 years of age (47.5 per cent of total deaths), and 580 deaths under 1 year of age (33.9 per cent of total deaths). There were 184 stillbirths, giving a percentage of 6.9 per cent of the total births.

Tuberculosis gave a death rate of 4.82, as compared with 3.89 for 1915, being 17 per cent of the total deaths this year, as compared with 12 per cent of the total deaths for the previous year.

#### COLON.

The average population of the city for the year was 27,012, among whom there were 691 deaths; 662 of these were from disease, giving a rate of 24.51 per thousand, as compared with 21.25 for the year 1915. The death rate for malaria was 0.33, as compared with the rate of 0.54 for the preceding year. The death rate for tuberculosis was 3.05, being 12 per cent of the entire deaths from all causes.

The birth rate for the year was 29.17, and the infant mortality 230.

Of the total deaths from disease, the percentage under 5 years of age was 39.

#### DIVISION OF HOSPITALS.

The number of employees in this division on June 30, 1916, was 510, as compared with 507 on the corresponding date of last year. The cost of the division was \$528,307.10, as compared with \$568,586.77 for the preceding year. (These figures include Corozal farm and medical storhouse.)

Charity patients numbering 714 were admitted, with a total of 41,373 days' treatment, as compared with 1,042 patients and 48,634 days in 1915.

The number of soldiers admitted to hospitals was 1,738, with 26,566 days' treatment, as compared with 1,969 admissions and 25,627 days' treatment for the preceding year.

#### ANCON HOSPITAL.

##### PATIENTS.

The average number of patients constantly present in Ancon Hospital during the year was 748, as compared with 802 for the year ending June 30, 1915. The average number of employees constantly sick in hospital was 267 for 1915-16, as against 331 for 1914-15.

The gross cost of the hospital for the year was \$394,991.37, as compared with \$435,661.49 for the preceding year. These figures include cost of operating the board of health laboratory and Corozal Hospital.

##### PERMANENT BUILDINGS.

Wards 3 and 4 were vacated in August, 1915, demolished, and the first unit of the permanent hospital erected on their site, being

completed and turned over for occupancy by hospital patients in June, 1916. All white American male ward patients were housed in this section June 30.

The building containing the medical out-patient clinic, X-ray apparatus, and library was vacated and turned over to the building division in August, 1915, for use as a local field office.

Wards 1 and 2 were vacated in June, 1916, demolished, and on their site construction was begun on the second unit of the permanent hospital. This unit will contain the white women's wards, nursery, children's ward, and the remainder of space in the building will be made into private rooms.

Wards 13 and 14 were vacated in June, 1916, demolished, and construction started on the new board of health laboratory.

The permanent concrete crematory building was completed during the year, cremating apparatus set up, and operations resumed in January, 1916. The building is located immediately adjacent to the new laboratory site.

#### TRANSPORTATION.

One double and one single team is the only animal transportation at present in service, the balance having been replaced by motor transportation consisting of one 1-ton truck, one 1½-ton truck, one ambulance, one hearse, which has resulted both in efficiency of service and economy.

The 1-ton truck was operated during the fiscal year 11,717 miles, at a cost of \$1,943.06 (which includes \$203.82 depreciation charges), a saving over the animal transportation it replaced of \$850.43, and a total saving to date of \$1,375.77. Truck was put in operation March 22, 1915; cost, \$1,705.64.

The 1½-ton truck cost \$2,574.28; put in service December 28, 1915; was operated 3,950 miles at an expense of \$549.23 (which includes \$157.82 depreciation); a saving of \$1,363.07 in animal transportation it replaced.

The ambulance cost \$1,412.74; put into service April 6, 1916; and was operated 1,835 miles at a cost of \$524.54 (including \$56.50 depreciation), a saving of \$35.60 over animal transportation. The showing is gratifying, however, in that as the motor ambulance does 24-hour duty, it has double the number of chauffeurs, one of whom is a white American foreman chauffeur who makes minor repairs and adjustments to all motor transportation; and as to handling emergency cases from Balboa docks, transfers to Corozal Hospital, and such other distant points, renders efficient service heretofore not obtainable by double or more the animal transportation actually replaced.

The hearse, put in service September, 1915, cost \$632.50; was operated 2,314 miles at a cost of \$526.72 (including \$117.80 depreciation), a saving over animal transportation which it replaced of \$432.28.

A 1-ton trailer cost \$120; was received and put in service June, 1916.

The total saving effected by motor transportation to June 30, on a capital expenditure of \$6,450.16, is \$3,206.62.

## X-RAY CLINIC.

Recent advances in roentgenology and radiotherapy rendered it necessary to provide increased and better facilities for conducting work of this character at Ancon Hospital.

During the past year the X-ray department was moved into larger and more suitable quarters and the latest model equipment provided and installed for making modern radiographic examinations. The new equipment includes one vertical roentgenoscope; one radiographic, stereoscopic, and fluoroscopic tube stand; one radiostereoscopic X-ray table with horizontal fluoroscopic attachments; one stereoscope; two Cooledge X-ray tubes with overhead wiring systems; a complete dark-room equipment, including a large soapstone developing tank with water-cooling apparatus for the rapid development of plates under tropical conditions.

To accommodate this apparatus and to provide the needed space for its satisfactory and economical operation, six rooms were set aside for use of this department. This arrangement provides an office and demonstrating room, examination room, fluoroscopic room, dark room, a dressing room for patients, and a filing room for plates.

In view of the great increase in the amount of X-ray work at Ancon Hospital, and its extension into fields other than surgical, it was deemed advisable to relieve the surgical clinic of the hospital from further responsibility for work of this nature. An independent department was established, effective January 1, 1916, and designated X-ray clinic. As chief of the clinic, an expert roentgenologist was secured, who devotes his entire time to this work.

## CHRONIC PATIENTS.

Sixty-five chronic patients received 10,163 days' care, at a cost of \$2,415.13.

## COROZAL HOSPITAL.

*Buildings.*—Two permanent buildings were added to the hospital and farm during the fiscal year; one a modern, concrete, fly-proof, compost pit containing four compartments, being erected on the farm, and the other a carpenter shop, being erected within the hospital inclosure.

A steam plant, consisting of boiler, pipe line, and sterilizer, was constructed to provide for the proper sterilization of all milk containers, as well as the disinfection of beds and bedding. This plant will also be used in connection with hydrotherapy and steam cooking.

Authority was granted and construction commenced on a modern chicken house, concrete foundation, capable of housing 2,000 chickens. The pigeon house was improved with a shelter shed, and will be further improved when the new chicken house is completed. A new pig-gery will be constructed soon.

*Hospital department.*—There were 253 patients in the asylum on July 1, 1915, of whom 146 were males and 107 females. At the close of June 30, 1916, the number of patients remaining was 291, of whom 173 were males and 118 females. The movement during the year is shown in the following table:



Remaining July 1, 1915:	
Male.....	146
Female.....	107
Admission:	
Male.....	120
Female.....	66
Discharges:	
Male.....	73
Female.....	29
Deaths:	
Male.....	20
Female.....	26
Remaining June 30, 1916:	
Male.....	173
Female.....	118

Of the admissions, 12 males and 1 female, and of the discharges, 16 males and 1 female, were patients transferred to Ancon Hospital for surgical treatment.

*Personnel.*—The increased number of patients and the desire to give them as near as possible the care and treatment received in similar institutions in the United States required some additions to the personnel. An additional physician specially trained in psychiatry was authorized and has reported for duty. The nursing staff was reorganized, creating the position of chief nurse, thus making the entire number of nurses eight, four female and four male.

During the year the hospital has been completely reorganized with almost an entire change of personnel. An effort is being made to keep complete records and histories, and to provide amusement, exercise, and occupation, such as is the custom in the United States. Already very favorable results have been obtained.

*Grounds.*—During the latter part of the fiscal year special attention has been given to the regrading and beautifying the hospital grounds, with gratifying results. The bare earth has given way to good lawns, many trees have been planted, and hedges constructed. All this work has been done with patient labor.

A garden has been laid out within the hospital inclosure, and good crops have been raised, the results having warranted plans for increasing the extent and variety of the vegetables produced.

*Farm department.*—The farm department has been reorganized and the position of assistant farm manager created. The number of cripples on the farm at the beginning of the fiscal year was 9 whites and 40 blacks. At the close of June 30, 1916, there were 9 whites and 44 blacks. No deaths occurred among the cripples.

*Dairy.*—During the second half of the fiscal year an experienced man, specially trained in dairying, was placed in charge of this branch of the farm. The standard adopted has been that of the best dairies in the States, and a careful laboratory check of the products is made to guarantee the contained standard of excellence. The milk production during the latter part of the year shows a reduction compared with the previous six months. For a few months the supply was not equal to the demand, due to the fact that many of the cows, failing to produce sufficient milk to warrant retention in the herd, were condemned and sold as beef. However, lately the milk production has been ample for all demands. Twenty-two young cows have been purchased and are gradually freshening, and the milk production will shortly be sufficient for any reasonable increase in demand. Since February 14, 1916, a daily count of the organ-

isms present in the milk has been made at the board of health laboratory. The highest count was 32,000 bacteria per c. c., the lowest count 450 c. c., the average being from 5,000 to 10,000 organisms per c. c. Periodic inspections of the dairy have been made by representatives of the board of health laboratory, and since the installation of the sterilizing plant for the milk utensils, have all been satisfactory. The milk of the dairy therefore is equal to the grade known as "certified milk" in the United States.

*Piggery.*—At the close of the year the piggery contained 2 registered boars, 92 hogs, 54 pigs, and 62 sucklings, or a total of 210.

*Poultry.*—The income from the poultry yard shows an increase during the latter part of the year, although for a few months the production materially decreased. At the end of the fiscal year the production record was an average of about 20 per cent. The flock numbered 526 hens on June 30. This will be increased by 500 new Rhode Islands Reds within a short time, and all will be placed in the new concrete chicken house being constructed. It is expected the egg production will shortly reach the desired average of 30 per cent.

*Garden.*—The sale of plants and flowers showed a large increase during the last half of the fiscal year. Vegetables and fruits produced a large income, and were readily disposed of to Ancon Hospital and the commissaries.

*Farm revenues.*—The following statement shows the comparative income from the four branches of the farm during the two six-months periods of the year:

	Dairy.	Piggery.	Poultry.	Garden.	Total.
July 1 to Dec. 31, 1915.....	\$6,992.67	\$711.27	\$786.55	\$1,363.55	\$9,854.04
Jan. 1 to June 30, 1916.....	6,670.34	894.07	885.65	2,295.35	10,745.41
Total for fiscal year.....	13,663.01	1,605.34	1,672.20	3,658.90	20,599.45

*General.*—The hospital at present shows the larger income, and more than makes up the small deficit on the farm. It is expected that before the end of the fiscal year 1917 the farm will show a gradual increase and a decided profit in its favor. Taking into consideration that only cripple labor, liberally paid, is employed on the farm, with the exception of a few able-bodied foremen, these results are most gratifying.

#### BOARD OF HEALTH LABORATORY.

The end of the year finds the laboratory about to move into a temporary building for a period of six months or more, while the new building is being completed. The new laboratory is to be a two-story concrete structure in the shape of a square open at the back. It will for the first time in the history of the laboratory department place the board of health laboratory in suitable surroundings.

The activities of the board of health laboratory have been many and varied. The following is a summary of the more important work done:

Three hundred and forty autopsies were performed and complete records made. These autopsies represent 80 per cent of the bodies

that have passed through the board of health laboratory for burial. The causes of death as determined by autopsy show that various forms of tuberculosis, prevailing almost entirely among the negroes, leads all other causes, with 80 cases. Next in their respective order as a cause of death are the following: Chronic nephritis 24, lobar pneumonia 21, external violence 19. Nearly always, in the negro of this list, the tuberculous lesion was active and progressive in type, while in members of the white race it is common to find arrested or encapsulated foci of the disease.

Important subsidiary factors found at autopsy have been syphilis, malaria, and intestinal lesions. Nearly all cases that come to autopsy have had a Wassermann test made. There were 55 cases with a positive test, and lesions in the several others indicated possible tertiary syphilis. Malaria, although causing death in but 8 cases was revealed by pigment in the pulp of the spleen or rib marrow, sometimes accompanied with the presence of few parasites in 44 additional cases. A routine examination of placental smears resulted in 9 positive cases out of 194 cases examined. Both the autopsy and placental results show a marked decline in this disease and it also shows that nearly all cases of active or latent malaria are in residents of the Atlantic end of the Zone. This appears to be indicated also by the mosquito census and hospital admissions for the disease. The intestinal diseases have also shown a marked decline so far as the autopsy records can be taken to indicate their prevalence. Not a case of amebic infection of intestine or liver has occurred in the present year's work. The bacillary type of dysentery is occasionally found.

Three nonresidents have come to autopsy as victims of yellow fever, but no plague cases have been found. No rabies in man or animal were encountered. Beriberi may have been present as the infantile type in two children entered as cardiac deaths.

Four hundred and ninety surgical specimens were received, examined, and carefully recorded. The detailed findings are of professional interest and will be published at a later date.

#### ANIMAL EXAMINATIONS.

*Rats.*—Fourteen thousand six hundred and eleven have been received from all parts of the Canal Zone, chiefly from the terminal cities. None, at autopsy, presented any evidence of plague, but four of them had extensive pulmonary abscess formations and three had large neoplasms of the sarcoma type. Muscle and intestinal parasites were quite commonly found.

*Hogs.*—Sixty-four hogs were received from the Corozal Hospital farm and hog cholera diagnosed in 41 of them. Diseases of the respiratory and its accessory systems accounted for the deaths in most other cases.

*Cows.*—Four cows and 2 calves were examined. Two cows showed tuberculous lesions. The rupture of a verminous aneurysm killed one and the cause of death was undetermined in the fourth. One calf died from general infection due to an infected umbilicus. The second was a "vaccine calf" which developed a gas-bacillus infection over the vaccinated area.

*Steers.*—Tissues examined from four steers that had died of anthrax.

*Rabbits.*—Two were examined. One possessed a large abdominal neoplasm and the other had sustained a fracture of the spine.

## MISCELLANEOUS.

One hundred and ninety-four placental smear examinations were made, and 9 were positive for malaria.

The diagnosis of leprosy has been established microscopically in 10 cases under suspicion.

Stained smears and dark field examinations have been made in 9 cases of syphilis and 2 cases of yaws.

Number of Wassermanns performed was 6,518, nearly double that of 1914-15, due to the increasing use of this test as a routine measure of diagnosis, and as a test of the efficiency of treatment.

There have been 46 positive diphtheria cultures during the year, mostly sporadic cases. Routine cultures were made in all cases of tonsillitis and practically all other mouth and throat lesions.

*Bacillus typhosus* has been recovered in blood culture from 19 cases and *B. paratyphosus* from 4 cases. Six cases were taken from ships, 6 came from the City of Panama and its suburbs, and the rest were about equally distributed in Colon and along the line.

The free examination for Panaman physicians of all cases of suspected contagious diseases has been continued.

All smallpox vaccine used on the Isthmus during the year has been manufactured at the laboratory, and it has given uniformly good results. It has been definitely proved for the Tropics at least, that less trouble immediately after vaccination is experienced if no powder, ointment, or other dressing be used.

A mosquito census was begun on September 10, 1915, and will be continued for a year for each collecting station in the Zone. The hand catches of the mosquitoes caught in barracks and quarters at the different line stations, military posts, and at Colon and Cristobal, have been sent to the laboratory daily for classification.

All the *Anopheles* were classified by species with the exception of those that were too badly damaged for identification and those were listed as damaged *Anopheles*. All *Stegomyia* (*Aedes calopus*) were identified. *Mansonia titillans* was not separated from the *Culex* at the beginning of this work, but was classified under the heading of *Culex* and allied genera until January, 1916—since which date they have been identified and counted separately. *Aedes taeniorhynchus* began its annual appearance during the early part of May, and all specimens have been identified and separated. When *Wyeomyia* appeared in sufficient numbers to make it worth while, they were identified as a genus.

All *Culex*, *Aedes*, and all other varieties with the exception of those mentioned above as being identified, are classed as *Culex* and allied genera.

Since the beginning of this work on September 10, 1915, up to and including June 30, 1916, the total number of mosquitoes of all varieties examined was 216,514. Of this number there were 56,507 *A. albimanus*, 1,008 *A. tarsimaculata*, 9 *A. argyritarsis*, 92 *A. malefactor*, 18 *A. apicimacula*, 28 *A. pseudopunctipennis*, 1 *A. eiseni*, 10,251 damaged *Anopheles*, 1,850 *Stegomyia* (*aedes calopus*), 40,850 *Mansonia titillans*, 561 *Aedes taeniorhynchus*, 2 *Aedeomyia squamipennis*, 465 *Wyeomyia*, 36 *Deinocerites*, 7 *Lesticocampa*, and 104,829 *Culex* and allied genera.

Dipterous fly larvæ that were received from several cases of human and animal myiasis were identified and bred out. The larvæ found

in the human cases were those of the "screw worm" fly, *Cochliomyia desvoidyi* (*chrysomyis macellaria*), the "blow fly," *Sarcophaga* sp., and *Dermatobia cyaniventris*. Larvæ of *Cochliomyia desvoidyi* and *Sarcophaga* sp. were found in the cases of animal myiasis. A half grown larvæ of *Dermatobia cyaniventris* taken from a man's neck was successfully transplanted into the neck of a guinea pig.

Experiments have been carried out to determine the toxicity of the venoms of some of the snakes found in the Canal Zone. The venoms of all snakes that could be secured alive were tested on guinea pigs; two species proved poisonous, the Coral snake, *Elaps fulvius*, and the *Erythrolamprus aesculapii*. The Coral snake, *Elaps fulvius*, was found to be the most highly venomous. It belongs to the sub-family *Elapine* and is related to the cobra found in the Old World. Their bite was found to be fatal to all small animals they were tested with. One of the smallest specimens secured, 16 inches long and smaller in diameter than a lead pencil, was venomous enough to kill a 605 gram guinea pig in 3½ hours. One week later this same snake was made to bite a dog weighing 8½ pounds and it died seven hours later. An average sized Coral which is about 22 inches long and less than ½ inch in diameter will eject about 2 milligrams of venom at a bite.

The *Erythrolamprus aesculapii* is red with black and white annuli and is often mistaken for the Coral snake, but as a rule is much larger than the Coral and the colored annuli are arranged differently. While this species is not as venomous as the *Elaps*, its bite is fatal to guinea pigs, but requires a longer time to produce death. One specimen about 33 inches long and ¾ inch in diameter required about 3 days to produce death in a guinea pig weighing 524 grams.

Specimens of *Orybelis accuminatus*, *Pseudoboa newwedii*, *Spilotes pullatus*, and three unidentified snakes were tested, but their bite produced no noticeable effect.

#### COLON HOSPITAL.

The new hospital and dispensary building was completed and turned over for occupancy on May 16, 1916. The building has been found quite satisfactory for its purpose. A new storehouse of reinforced concrete, situated just south of the service building and separated from it by a service road now under construction, is practically completed and ready for occupancy.

The plans for a reinforced concrete garage, morgue, and a four-family type B house for use of physicians, have been prepared and work of construction will be begun shortly.

The present quarters for nurses in a section of the old hospital building, are not satisfactory. Estimates will be submitted for your approval, for the construction of a new concrete building for the nurses, during the coming fiscal year.

Detailed statistics are shown in Table XIX.

#### PALO SECO.

The number of patients at the Leper Asylum is constantly increasing; there were 56 at the beginning of the year and 65 at the close; there were 13 admissions and 4 deaths. As additional accommodations are necessary, a new ward building has been authorized

and the work begun; the entire labor is to be furnished by the leper inmates.

During the year the dining room was enlarged to twice its original length, making it a suitable congregating place for the patients in which entertainments can be given. The space under the dining room was graded, given a concrete floor, and inclosed for use as a recreation hall; it is screened in, furnished with small tables, and supplied with games and a small library of books in English, Spanish, and French, and with magazines and daily papers. These facilities have added greatly to the comfort and pleasure of the patients. Many contributions of books and magazines by outside friends were received, and much appreciated.

Telephone connection with Balboa was established during the year, which greatly facilitates the transaction of business. Electricity was introduced during the year by extending the line from the channel light near Farfan Beach; all buildings were wired and lights placed in each room; 12 street lights were installed also. This has not only proved an economy, but it has diminished risk from fire. A new 15-horsepower electric motor and pump for lifting water to the supply tanks was installed during the year; connections were made also by which pumping may be done direct to the main line or buildings, in case of fire. The pump in general has operated satisfactorily.

An extension of 960 feet was made to the present sewer line during the year, carrying the line away from the beach to the southwest and out beyond the last reef from the asylum proper, which allows the sewage to be discharged about 1,200 feet from the beach at low tide.

A 3½-horsepower Evinrude detachable motor was purchased during the year, with which the asylum was able to establish a daily service to and from Balboa, carrying necessary supplies for the institution, thus limiting the amount of launch service formerly required from the marine division. Formerly the expense for launch service during the month amounted to about one-tenth of the total monthly expense of the asylum; the present cost of operation amounts to about \$41 per month.

Nearly all the male patients desired to do planting this year, and suitable ground was allotted to each patient for the purpose. About 40 acres were thus allotted; 25 acres are planted in corn; other crops planted were yucca, otoy, plantains, and yams. The products of these cultivated areas are sold by the patients to the mess of the institution.

Detailed statistics are shown in Table XX.

#### SANTO TOMAS HOSPITAL.

The number of patients requiring treatment continues to increase and the institution is now overcrowded. The average number of patients constantly sick was 451.92 as compared with 441.57 for the previous year. The number of days relief furnished patients was 165,402 as compared with 161,174 the previous year.

Separate provision should be made for the large number of cases of tuberculosis now under treatment in Santo Tomas Hospital. If tubercular cases were treated in a separate institution the accommodations for other cases would be sufficient.

Detailed statistics are shown in Table XXI.

## DISTRICT DISPENSARIES.

Two line dispensaries were closed during the year, namely, Corozal and Naos Island, leaving 5 at the close of the year—not including the dispensaries at Ancon and Colon Hospitals. All dispensaries have district physicians with the exception of Gamboa stockade, where a male nurse is stationed and medical attendance is furnished from the Pedro Miguel dispensary.

The average weekly percentage of admission rates from malaria from the various districts, for the year, was as follows:

Gatun, 0.319; Cristobal, 0.140; Ancon-Corozal, 0.104; Paraiso, 0.090; Pedro Miguel, 0.084; Culebra-Empire (west of canal), 0.079; Balboa 0.062.

## MEDICAL STOREHOUSE.

A fireproof room was built in the medical storehouse to provide for the protection of case histories and hospital cards against fire until such time as they are transferred to the permanent chart room in the proposed administration building of Ancon Hospital.

There has been no change in organization or operation worthy of note during the year. Value of drugs and miscellaneous expendable supplies issued during the year was \$33,933.14.

## SANITATION.

## CANAL ZONE.

The total cost of the division in 1916 was \$175,317.83, as compared with \$130,867.07 for 1915. The per capita cost of Zone sanitation proper per day, based on the number of employees, was \$0.015, as compared with \$0.008 for 1915.

During the past year the work of this division has been carried on along the usual lines covering antimalaria work, the destruction of rats, the inspection of all residence districts in the Zone, and the inauguration of measures for the correction of unsanitary conditions wherever practicable. The district sanitary inspectors also arrange for the disposition of the bodies of the dead, in this respect acting as undertakers.

The experience of the past years has demonstrated that extensive work must be constantly maintained in and around residence districts to protect employees from malaria, and it is found that in the districts at the north end of the canal where the *Anopheles albimanus* mosquito is the one most commonly found, the work thus far done has controlled the development of malaria only in a limited degree, though the number of cases reported is continually decreasing. On the other hand, the districts south of Gamboa have relatively few malaria-bearing mosquitoes and are consequently comparatively free from malaria. The decrease in the number of admissions of employees to sick report for malaria on the Zone, exclusive of the terminal cities, is shown by the following figures:

	1913-14	1914-15	1915-16
Actual admissions.....	2,832	1,042	517
Rate per 1,000 employees.....	103.71	77.67	56.79

The transition from the period of canal construction to that of canal operation is being accomplished gradually and results in greater permanency in locations in which employees work and have their homes, which in turn makes it possible for this division to install much work of a permanent character, which was impossible during the construction period, and which serves the double purpose of eliminating depressions which hold water and of preparing the area for grass cutting by the mowing machines, thereby greatly reducing the expense of maintenance. This work can be advantageously pushed until ample facilities are provided to take care of the surface water in and about our residence districts, so that these areas will be practically free from stagnant water or water containing vegetable growths which favor the development of mosquitoes. It is roughly estimated that about one-third of the work of this nature which the districts require was accomplished during the past year, and plans have been made for the continuance of the work during the coming year.

The completion of the canal and the consequent influx of ships to our terminal ports greatly increases the opportunities for contamination of the Zone by plague-infected rats. It is well known that rat plague is endemic in many of the ports from which these ships come. This division employs men to destroy rats by all means possible and in all places but especially along water frontage. The bodies of all rats found are sent to the board of health laboratory for examination for plague infection, and thus far no plague has been found. In view of the almost inestimable value of this freedom from rat plague to the Canal Zone and in consideration of the risk of infection which increases with the number of ships handled by the canal, it is regarded as highly important that the work of rat proofing our water frontage be vigorously pushed and that old wooden construction which can not be rendered rat proof be eliminated along the entire length of the canal.

The breeding of flies has been considerably limited in the residence districts by careful house-to-house inspection, but this division has been hampered in this work by the continued maintenance of old stables, especially in the Balboa district, and by the crude garbage incinerator in use, in which complete consumption of garbage is difficult, especially during heavy rains. The construction of modern stables is under way, and the erection of a good incinerator will be commenced in the near future. This should result in a great improvement of conditions so far as fly breeding is concerned.

The number of sanitary districts into which the Zone is divided was decreased by one when Corozal was turned over to the military forces, though the upkeep of only about one-third of the sanitary district of Corozal was assumed by the troops. The remaining two-thirds of the district was added to Ancon district, and the district sanitary inspector of Ancon district, whose duties include the superintendence of the larvacide factory, was given the sanitary inspector previously allotted to Corozal as his assistant. The successful operation of the large sanitary districts with the present force of inspectors is made possible only by the fact that the inspectors at present employed have been thoroughly acquainted with the methods of work employed on the Canal Zone and with the characteristics of their districts for a long period of years, and we are able to handle much more territory than men new to the work and the country would be able to manage. Until maintenance work is reduced by



the installation of the permanent drainage measures referred to above or the area to be cared for is decreased, reduction of the force of inspectors on Zone sanitation can not be consistently made.

#### PANAMA.

Several sanitary ordinances for the terminal cities, referred to in the last annual report, have not yet been published in the Official Gazette, though the subject of much correspondence with the Panama Government. Recently the matter has been taken up through the State Department, and it is hoped the desired end will be accomplished, for it is important that these ordinances be made effective without further delay.

#### DISEASES.

*Malaria*.—There has been a great reduction in the number of cases of malaria among employees of The Panama Canal and Panama Railroad sent to Ancon Hospital from Panama, there being only 68 such admissions during the year as against 589 for the preceding year. Almost without exception employees suffering with malaria are admitted to Ancon Hospital, which enables us to have a correct check at all times on the incidence of malaria among employees in the city. The number of employees living in Panama approximates 10,000.

In order to accomplish the above successful results, it has been necessary to maintain approximately 30 miles of ditches for drainage purpose. This low malarial rate can only be obtained by constant watchfulness on the part of a force of competent, well-trained sanitary inspectors, with ample equipment and material for carrying on their work. There will always be some cases of malaria in the city on account of the fact that there are a number of infected districts lying just outside the limits of our work, such as Savannas, Juan Diaz, Old Panama, etc., to which places the public can not, of course, be restricted from visiting; and this results in the occurrence of a small percentage of cases.

There has been a very considerable growth in the area of the city during the past fiscal year, which is extending eastward out toward the Savannas, away from the Canal Zone. This has necessitated our extending our antimosquito work out in that direction to include the newly developed sections of the exposition grounds and Bella Vista. Up to the present the cost of the work of installing and maintaining drainage ditches at these two places has been borne by the Government of Panama and the Panama Land & Development Co., the owners of the two districts.

*Tuberculosis*.—The prevalence of tuberculosis, which has been commented upon in previous reports, remains unabated, and it is hoped that means will be available during the ensuing year for undertaking the work against this disease on a more extended scale.

From the total number of deaths from all forms of tuberculosis, it has been found that in Panama City there exists a rate of 465 per 100,000. This is considerably higher than the average rate among the negro population of the larger southern cities in the United States, and is more than three times as great as for the registration area of the United States during 1914, which was 146.8 per 100,000 population.

From the number of deaths recorded, a conservative estimate would show that there are over 1,000 ambulant untreated cases in

the city, and until an institution can be erected and maintained for the scientific care of a majority of these cases there is but little hope for an improvement in conditions.

*Typhoid*.—A total of 12 cases of typhoid fever were reported which were actually chargeable to the City of Panama, of which number 6 cases terminated fatally. None of these cases were directly traceable to any particular source.

*Scarlet fever*.—No cases of scarlet fever were reported during the year.

*Diphtheria*.—There were 23 cases of diphtheria reported during the year, of which 3 were fatal. Numerous cultures were taken in suspected cases, prompt investigation being made of every report.

*Measles*.—There were 366 cases of measles reported during the year, with 1 death. The epidemic of this disease reported in the annual report for 1915 reached its height in August, when there were 241 cases reported, and declined rapidly thereafter.

*Mumps, whooping cough, and chicken pox*.—Cases of these diseases have been reported as occurring from time to time, which were isolated when practicable. There has been a perceptible increase in the number of reported cases of chicken pox in the past three months, and undoubtedly many mild cases have not been reported to this office. Reported cases of chicken pox were seen in order to confirm the diagnosis.

*Vaccination*.—During the year 2,409 vaccinations were performed, chiefly among the school children. Reexamination shows that about 90 per cent of this number were successful "takes" and no serious infections occurred.

#### GENERAL SANITATION.

The usual routine work of house inspection by the district sanitary inspectors with their gangs has been carried on. The number of nuisance notices served and nuisances abated has increased from a monthly average of 200 during the fiscal year 1915 to 400 during the year just finished.

#### MOSQUITO WORK.

In pursuing the house inspections we find that inspectors discovered and destroyed on an average 279 deposits of mosquito larvæ per month. Of these, the *stegomyia* breeding places have averaged 143 per month. This emphasizes the importance of maintaining this work, as lessened care in this respect would increase the liability of an epidemic should any undiscovered cases of yellow fever gain an entrance to the city.

Some *stegomyia* breeding was encountered at the public dump in the thousands of old cans, etc., found there, and this was eliminated through flattening and burying old tins and careful oiling of all suspected places.

*Stegomyia* breeding was also encountered in the swimming pool of the gymnasium of the National Institute. This was noted during vacation, when the pool had been undisturbed for some time. The pool was drained and cleaned, after which no further trouble was experienced.

Introduction of mosquitoes to the city by railroad and street cars from districts in which no antimosquito work is being done was noted. Practically all of these were of a harmless type of *culex*.

## RAT DESTRUCTION.

Efforts toward the complete rat-proofing of all buildings in the city are being carried on continually, and it is hoped to obtain this result during the coming year. The methods in vogue by this office are those which met with such success in the cities of San Francisco, New Orleans, and Habana, where in recent years the occurrence of plague has been stamped out through repairs to houses in such a way as to eliminate all possibility of rat harbors.

The monthly catch of rats throughout the city has averaged 779 rats per month, the work of trapping being carried on by the inspectors in connection with their regular routine. All rats caught are sent to the laboratory for inspection for plague infection and none were reported infected.

This is one of the most important features of prevention work maintained by the health department. As the rats are trapped and sent to the laboratory they are labeled, so that if an infected rat is found this office can at once locate the focus of the plague infection and institute the measures necessary to prevent the spread of the disease.

## FLY PREVENTION.

An average of 122 fly-breeding places per month have been discovered during the fiscal year by the inspectors in their routine work. These places were destroyed by the application of larvacide, and the attention of the persons in charge of the property where found was directed to the occurrence.

By gaining the cooperation of the residents of the city, considerable improvement in conditions in this regard has been noted. Trapping of flies on an extensive scale was carried on by this office in various parts of the city, and no less than 328 quarts of flies were destroyed in this manner. It has been found that there is an average of 13,000 flies to the quart; this accounts for the destruction of 4,265,000 adult flies destroyed by trapping during the year. This lessens the presence of flies per capita considerably.

## STABLES.

During the year the Panama Railroad Company completed its public stables on B Street, which were constructed along lines to limit the occurrences of the nuisances so frequently found at such establishments, with particular reference to the occurrence of fly breeding and rat infestation.

This is one of the most important sanitary accomplishments during the year as it made possible the elimination of a large number of dirty, ill-kept stables in the most congested portions of the city.

At the same time sanitary stalls for horses may be obtained for a nominal sum, which the owners of animals do not find burdensome and the city receives the benefit of the segregation of these establishments to certain defined districts.

## BUILDING INSPECTION, CONSTRUCTION, AND REPAIR.

The following summary shows the work accomplished in the line of building construction and repair during the year:

Buildings inspected, 64,342; plans approved, 228; repair permits issued, 1,004; buildings demolished, 53.

Under the head of buildings inspected is included the weekly routine inspections made by the district inspectors, whereby each inspector visits each house in his district at least once each week.

#### SIDEWALKS.

Property owners are required to keep the sidewalks adjacent to their property in good repair, clean, and free from obstructions. In the course of repairs, many sidewalks have been regraded with a view to presenting a safer and more comfortable walking surface.

#### FOOD INSPECTION.

Under this heading is included the various establishments for the production and handling of food stuffs, of which we find at present in the city the following:

Twenty-two bakeries, 30 hotels, 42 restaurants, 5 clubs, 25 bottling works, 33 dairies, and 65 milk vendors.

Regular inspections are made of all these establishments, and below is given a summary of the work accomplished:

Bakeries inspected.....	242
Hotels, clubs, and restaurants inspected.....	260
Bottling works inspected.....	100
Dairies inspected.....	314
Milk samples taken.....	201
Miscellaneous inspections.....	632
Notices served.....	619

In the prosecution of this work various foodstuffs, such as meats, fish, milk, flour, vegetables, fruits, etc., have been found unfit for human consumption, condemned, and destroyed. Special effort has been made to improve the standard of dairies, and considerable instruction was given in the proper methods of handling and production of milk.

The chemical examination of specimens of milk from the dairies of Panama and its vicinity (as well as of Colon), which is made at the board of health laboratory, has shown these milks to be with very few exceptions of a quality considerably better than that prescribed by law. Specimens of confectionery taken from the establishments manufacturing them in Panama were also examined by the board of health laboratory, and found to be free from adulteration and from any substance likely to prove injurious to health.

#### STREET CLEANING AND SPRINKLING.

Experience has shown that the present system of cleaning the streets by handwork is the most economical, therefore the methods are the same as heretofore. A man, equipped with broom, shovel, and push cart, is assigned a certain section of street area and required to keep that clean at all times; he collects and deposits the sweepings as he goes along, and in this way it is possible for one man to clean his street area several times during a working day.

During the dry season two, and sometimes three, street sprinklers are required to keep the dust down, and during the rainy season this sprinkler is so little required that only in the shopping district is it necessary to sprinkle the streets at times.

## GARBAGE COLLECTION AND DISPOSAL.

An average of 5,000 loads of garbage of all kinds is collected per month, approximating 9,000 cubic yards. This includes house garbage, rubbish, refuse, stable manure, etc., all of which is hauled to the public dump for disposal.

This method of disposal is unsatisfactory, being attended by the occurrence of very serious nuisances. It has been found that the public dump is our most prolific breeder of rats, flies, and *stegomyia* mosquitoes. Constant watchfulness has to be exercised to keep these at a minimum.

The erection of a modern incinerating plant for the destruction of garbage and refuse is an urgent necessity. Another necessity is the installation of a compost pit for treating manure with a view to making it available for fertilizer and at the same time obviating the possibility of fly breeding.

All property owners are required to maintain a sufficient number of garbage cans at their buildings for the use of tenants, and this office has undertaken to provide these cans with suitable covers, either metal or wooden, as may be most advantageous. These cans are sold to the public at a price sufficient to cover their cost plus handling expenses.

## COLON.

The prime objective for the year has been the general amelioration of health conditions, laying particular emphasis upon antimalarial measures. The total number of cases of malaria reported for the last six months of the present fiscal year was 52, as compared with 99 for the last six months of the preceding fiscal year, which is the period available for ready comparison, as it was then that the system of summarizing separately the reports on communicable diseases was put into operation. The reduction in malaria has been obtained by the complete elimination of *anopheles* breeding on Manzanillo Island, in Colon and Cristobal proper, by a combination of ditching and filling certain areas previously characterized by persistent breeding (especially around the Radio Station and the Panama Railroad corral in Colon, and Camp Bied in Cristobal), as well as by increasing the number of weekly inspections of each area and of oiling the same when necessary, and also by the hydraulic fills made near Pier No. 13, and the dry fills at Mount Hope. The area of inspection and oiling was also extended in June, 1916, in the Mount Hope district to include some previously unworked territory, as the health office was convinced that these areas were a source of adult *anopheles* found around the dry dock and at Camp Bied. The work was also extended on Mindi Island and around the Arcia dairy pastures for the same reason.

The plan of following up reports of cases of malaria by an investigation either by the health officer or a sanitary inspector, which was inaugurated this year, has produced admirable results in helping to localize responsibility. A number of cases have shown the incidence of mosquitoes in outlying districts, notably the Manajal plantation, and at Las Minas.

## GENERAL SANITATION.

The same routine methods of inspection of the district prevailed as for the preceding fiscal year, i. e., the entire district of Colon-Cristobal-Mount Hope is made up of four divisions, each presided over

by a sanitary inspector; each inspector has a working gang under his charge whose work is the destruction of mosquito and fly larvæ, inspection of buildings, yards, and parks; the removal of garbage and rubbish from premises and placing it upon wagons; the examination of closets, sinks, and sewer traps, and the regular inspection of the city's shore line. Inspectors also inspect piers, shops, markets, bakeries, ice-cream parlors, cantinas, bottling works, stores, stables, gardens, and abattoirs. It is the function of an inspector to serve notices against nuisances, and report cases for penalty and to appear as witness against offenders against the sanitary code; he assists the health officer in the investigation of communicable diseases and establishes quarantine where it is advisable. One inspector is conversant with disinfection and is especially charged with this work, which has been applied almost exclusively in tuberculosis cases during the past year. A highly important duty of inspectors is educational in its bearing and has to do with explanation of regulations and public-health problems. This is incidental to their other work which carries them constantly into houses of the people and brings them into frequent personal relationship with the individual population.

#### MOSQUITO, RAT, AND FLY WORK.

Especial activities were inaugurated for the elimination of *stegomyia* in the cities of Colon and Cristobal. The public was advised through the press and circulars with reference to the habits and breeding places of these mosquitoes, and exhaustive examinations were carried on by the health inspectors with the view of their elimination. It is of interest to note that no *stegomyia* breeding was found except in the containers at the Colon dump, where special measures were taken for its control.

The reduction of other species of mosquitoes has been noticeable, due to the large amount of permanent work that has been accomplished in the marsh lands of Mount Hope. The catching of adult mosquitoes has been carried on daily, and the use of the glass "flight detector" was of utility in helping to establish the source of *anopheles* coming into Colon. Crab holes have been oiled on an extensive scale, to control breeding from this source.

Rat infestation is at a low point. Trapping has been effectively carried out, and it is noteworthy that the use of oil of anise seems to render the ordinary bait more attractive to these animals. Food boxes in stables were required to be metal lined against rats, and the fowl coops also.

Colon has long been noted for its relative freedom from flies, caused largely by the concentration of stables into defined places and the prompt removal of manure, the use of larvacide to kill adults and to obviate small breeding places difficult or impossible to treat otherwise, and the rigorous elimination of rubbish. Careful attention to abattoirs, to the storage of hides and horns, and to all special trades likely to favor fly breeding has also helped toward this consummation.

#### FOOD INSPECTION.

A complete physical examination of all bakers was completed during May, and health certificates were issued. No one without a

certificate is allowed to ply his trade. Four new concrete bakeries were built to replace old ones destroyed by the fire of April, 1915, and these are a great improvement over the former ones. Structural repairs were required in others, and still others are pending. Some bakeries were necessarily overworked as a result of the fire and could not be remodeled conveniently until the congestion was relieved by the rebuilding of the city. A number of restaurants were made to conform to the sanitary regulations. Street vendors of food-stuffs have received especial attention, being required to keep their wares under appropriate protective devices.

#### SCHOOL INSPECTION.

An inspection of the Canal Zone school buildings was made before the session opened, and recommendations were made for the correction of such defects having a sanitary bearing. Where indicated, the disinfection of schoolbooks was made before they were issued to the pupils.

The cooperation of the principals of the schools was obtained in the matter of reporting suspected cases of infectious disease and in regard to the vaccination of pupils.

No school epidemic has occurred, and the general health of the school population has been excellent.

#### STREET CLEANING.

The work of the health department in this line was heavily augmented by the rebuilding of the city, following the fire of April, 1915, and the *débris* incident thereto. A new departure from the practice previously obtaining was inaugurated in the collection of this *débris*. Instead of waiting until construction or repairs on a building were completed to have rubbish removed, its removal is now required as soon as a half-wagon load accumulates, which keeps the streets freer of obstruction.

The oiling of the streets with crude oil once in a season has been attended with good results in allaying dust and producing a condition of the surface coating not unlike asphalt.

#### GARBAGE REMOVAL.

This work has increased considerably, due to the arrangement made by the health office for the proper handling and disposal of ship's garbage. All ships were provided garbage cans for the deposit of refuse. The cans are daily assembled in a nuisance-proof garbage shed conveniently situated to the docks, and the material subsequently removed by wagon transportation to Colon dump for incineration.

A modification of the standard stand for garbage cans in use here for several years has been made by using a concrete base and metal cover; this is more easily kept clean and is more durable.

#### BUILDINGS.

The construction of concrete buildings in the burned area of Colon has progressed rapidly and 181 have been completed. The buildings provided housing facilities for the fire refugees, and in conse-

quence the refugee camp was abandoned during the month of October, 1915. Two hundred and ninety-seven tents and forty-three box cars that were occupied by refugees were vacated and the wash-houses and range closets removed. The health conditions of this camp throughout the entire six months' duration were very satisfactory; with the exception of four cases of malaria and an equal number of mumps and measles, no sickness prevailed. Measures for improving the camp site and restoring the parkway, E Street, have been completed.

#### NOTIFIABLE DISEASES.

The plan of requiring a report on communicable diseases from physicians and hospitals, and following up these cases, has been maintained. It is noteworthy that during six months of this fiscal year, as compared with the same six months of the last year, the number of these cases was 161 against 319.

#### GENERAL.

Permanent improvements having a sanitary bearing, and made upon the recommendations of the health office, have been accomplished as follows:

1. A modern and sanitary cattle pen was constructed and provided with a vat containing a suitable solution in which cattle are dipped for the relief of ticks. Approaches and roads were filled and graded, so as to eliminate hoof prints and consequent mosquito breeding.

2. Structural improvements in the swimming pool at Hotel Washington, to make it conform to the requirements of the sanitary code.

3. Structural improvement of the stables, with especial reference to rat-proofing. The Panama Railroad stables underwent a thorough renovation.

4. The construction by the health department of a compost heap to control fly breeding and to meet the demand for stable manure by gardeners.

#### QUARANTINE DIVISION.

The total number of vessels inspected in quarantine, including Bocas del Toro, during the year, was 2,238, as against 2,282 for the preceding fiscal year, and 1,831 for the fiscal year 1914. The maximum number of ships received in any one month was 263, in July, 1915; the minimum number, 113, occurring in the month of December, the marked decrease being accounted for by the closure of the canal.

At the Balboa quarantine station concrete sidewalks have been put in, trees and hedges planted, and a type 17 modified cottage erected for the use of the additional medical officer now on duty at the station. The small boat landing for this station was completed in November, and has since been in use; quarantine passengers are now landed directly at the station from this pier. During the month of May this pier was turned over to the public use with the privilege of exclusive use by the quarantine division at the time of landing passengers.



The plague situation along the west coast of South America has shown no improvement, but on the other hand seems to be growing progressively worse. Reports from time to time of cases along the Chilean coast leads us to consider Chilean ports as far south as Valparaiso as infected. The plague situation in Peru shows no changes for the better, and recently newspaper reports indicated the existence of an unusual number of cases of this disease in the vicinity of Paita. Guayaquil, Ecuador, and vicinity, report from January 1 to April 30, 1916, 545 cases of plague, with 218 deaths, while during December, 1915, 188 cases of plague were reported, with 71 deaths. The appearance of a case of plague during the month of May, at the port of Manta, Ecuador, shows an extension northward of this disease; Manta, until the report of this case, having been declared free of plague for several years. Plague is also reported in Argentina, in 10 localities; in all probability being an extension of the disease from the west coast eastward.

The plague situation in New Orleans has shown great improvement, though an occasional case of rat plague is reported from time to time.

Anthrax was recognized among the cattle at Colon, the first part of April, 1916, although it is probable that scattered cases had occurred in March. The records of the office show that this is the third successive year in which the disease has appeared. In former years it was not extensive because there was comparatively few cattle on the pastures.

During April there were 85 deaths among the cattle, during May, 23; and in June, 8. While not all animals were examined bacteriologically, there is little doubt of the correctness of the diagnosis as the herds were under the observation of two veterinary surgeons and experienced cattle men. The deaths were not equally distributed, but occurred principally in pastures 6 and 7, 8 and 9, 21, 22, 23, 24, 25, 36, 37, upper 59, and lower 59, and these pastures were abandoned early and the cattle on them passed through a five-day quarantine period on pastures 26, 27, 33, 34, and 35, before being slaughtered. The five so-called quarantine pastures have remained free of the disease from the beginning.

The greater part of the present Colon pastures are infected, and if used as they are at present, will bring about an annual recurrence at the end of each dry season. Fortunately, some additional pastures will be ready in the fall of 1916.

The heavily infected pastures listed above will have to be abandoned in whole or in part for a long period, unless thorough drainage and improved watering places bring about an early cure.

During the fiscal year the veterinarian of the health department made 7,580 quarantine inspections, and 8,198 ante and post mortem inspections of cattle for the supply department; 229 cattle and 200 swine were inspected for outside interests, and during March, 1916, 73 cattle at the Corozal farm were tuberculin tested.

Detailed statistics are shown in Table XXV.

Respectfully submitted.

D. C. HOWARD,  
*Chief Health Officer.*

Maj. Gen. GEO. W. GOETHALS, United States Army,  
*Governor, The Panama Canal, Balboa Heights, Canal Zone.*

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TABLE I.—ADMISSIONS, DEATHS, AND NONEFFECTIVE RATES FOR EMPLOYEES:  
DEATHS OF RESIDENTS OF PANAMA, COLON, AND THE CANAL ZONE.

## ABSOLUTE NUMBERS.

Color.	Average number of employees.	Admissions to hospitals.			Deaths.			Noneffective from sickness. <sup>1</sup>	
		Total.	Disease.	External causes.	Total.	Disease.	External causes.	Days treated.	Constantly non-effective.
Year 1915-16:									
White.....	4,592	1,620	1,356	264	21	15	6	31,719	86.90
Colored.....	28,956	3,908	2,867	1,041	202	152	50	91,633	251.05
Total.....	33,548	5,528	4,223	1,305	223	167	56	123,352	337.95
Year 1914-15:									
White.....	5,595	2,306	1,940	366	34	17	17	39,449	108.08
Colored.....	32,120	5,395	3,974	1,421	184	119	65	107,496	294.51
Total.....	37,715	7,701	5,914	1,787	218	136	82	146,945	402.59

PROPORTIONATE NUMBERS.<sup>2</sup>

Year 1915-16:									
White.....	4,592	352.71	295.23	57.48	4.57	3.26	1.31	.....	18.92
Colored.....	28,956	134.96	99.01	35.95	6.98	5.25	1.73	.....	8.67
Total.....	33,548	164.78	125.88	38.90	6.65	4.98	1.67	.....	10.08
Year 1914-15:									
White.....	5,595	412.15	346.74	65.41	6.08	3.04	3.04	.....	19.32
Colored.....	32,120	167.96	123.72	44.24	5.72	3.70	2.02	.....	9.16
Total.....	37,715	204.18	156.81	47.37	5.78	3.61	2.17	.....	10.67

<sup>1</sup> Includes both hospitals and quarters.<sup>2</sup> Annual average per 1,000.

TABLE I.—ADMISSIONS, DEATHS, AND NONEFFECTIVE RATES FOR EMPLOYEES: DEATHS OF RESIDENTS OF PANAMA, COLON, AND THE CANAL ZONE—Continued.

DEATHS OF RESIDENTS OF THE CITIES OF PANAMA, COLON, AND THE CANAL ZONE.

Place.	Average population.	Deaths.			Annual average per 1,000.		
		Total.	Disease.	External causes.	Total.	Disease.	External causes.
Year 1915-16:							
Panama.....	60,576	1,710	1,652	58	28.23	27.27	0.96
Colon.....	27,012	691	662	29	25.58	24.51	1.07
Canal Zone.....	31,384	398	346	52	12.68	11.02	1.66
Total.....	118,972	2,799	2,660	139	23.53	22.36	1.17
Year 1914-15:							
Panama.....	60,382	1,924	1,856	68	31.86	30.74	1.12
Colon.....	27,815	627	591	36	22.54	21.25	1.29
Canal Zone.....	35,249	478	415	63	13.56	11.77	1.79
Total.....	123,446	3,029	2,862	167	24.54	23.19	1.35

TABLE II.—DEATHS BY AGE, COLOR, AND SEX.

Age.	White.			Colored.			Yellow.			Total.		
	Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.	Male.	Female.	Total.
Under 1 year.....	52	33	85	428	348	776	7	3	10	487	384	871
1 to 4 years.....	21	12	33	188	159	347	1	1	2	209	172	381
5 to 10 years.....	4	4	8	23	17	40	1	1	2	27	22	49
11 to 20 years.....	8	2	10	49	44	93	1	1	2	57	47	104
21 to 30 years.....	25	10	35	287	167	454	1	2	3	313	178	491
31 to 40 years.....	46	9	55	210	120	330	6	6	12	262	129	391
41 to 50 years.....	18	9	27	127	85	212	6	6	12	151	94	245
51 to 60 years.....	16	1	17	66	38	104	4	4	8	86	39	125
61 to 70 years.....	10	6	16	35	21	56	2	2	4	47	27	74
71 to 80 years.....	8	5	13	7	16	23	1	1	2	15	21	36
81 to 90 years.....	2	2	4	3	7	10	1	1	2	5	9	14
91 to 100 years.....	1	1	2	2	2	4	1	1	2	3	3	6
101 to 110 years.....	1	1	2	1	1	2	1	1	2	1	1	2
Unknown.....	1	1	2	10	3	13	1	1	2	11	3	14
Total.....	210	94	304	1,434	1,027	2,461	27	7	34	1,671	1,128	2,799

TABLE III.—DEATHS BY NATIONALITY.

Nations.	Employees.	Nonemployees.	Total.	Nations.	Employees.	Nonemployees.	Total.
Antigua.....	6	23	29	Martinique.....	3	60	63
Austria.....	2	2	4	Mexico.....	1	4	5
Bahama Islands.....	4	4	8	Montserrat.....	3	10	13
Barbados.....	52	429	481	Nassau.....	1	3	4
Bermuda Islands.....	1	1	2	Nevis.....	1	1	2
Bolivia.....	1	1	2	Nicaragua.....	1	4	5
Canada.....	2	2	4	Norway.....	1	1	2
Canary Islands.....	1	1	2	Panama.....	13	882	895
Chile.....	2	2	4	Peru.....	3	12	15
China.....	34	34	68	Philippines.....	1	1	2
Colombia.....	7	113	120	Porto Rico.....	1	1	2
Costa Rica.....	1	5	6	Portugal.....	1	2	3
Cuba.....	1	2	3	Persia.....	1	1	2
Curacao.....	1	1	2	Russia.....	1	1	2
Demarara.....	2	12	14	Salvador.....	1	1	2
Dominica.....	3	2	5	Scotland.....	1	2	3
Ecuador.....	6	6	12	St. Kitts.....	1	5	6
England.....	5	5	10	St. Lucia.....	4	44	48
Fortune Islands.....	3	3	6	St. Thomas.....	1	7	8
France.....	10	10	20	St. Vincent.....	6	18	24
Germany.....	2	2	4	Spain.....	1	31	32
Greece.....	2	4	6	Sweden.....	1	1	2
Grenada.....	2	29	31	Tobago.....	4	1	5
Guadeloupe.....	7	19	26	Trinidad.....	17	27	44
Guiana, British.....	3	3	6	United States.....	17	46	63
Haiti.....	4	4	8	Venezuela.....	1	10	11
Honduras.....	1	3	4	West Indies.....	2	2	4
India.....	1	1	2	Unknown.....	1	15	16
Italy.....	11	11	22				
Jamaica.....	83	649	732	Total.....	223	2,576	2,799
Japan.....	1	1	2				

TABLE IV.—CAUSES OF DEATH OF EMPLOYEES OF THE PANAMA CANAL AND PANAMA RAILROAD.

Causes of death.	White.	Colored.	Total.
Alcoholism, acute and chronic.....	2	.....	2
Anemia.....	.....	2	2
Aneurysm.....	.....	5	5
Apoplexy, cerebral hemorrhage.....	1	5	6
Brain, softening of.....	.....	1	1
Cancer and other malignant tumors of stomach and liver.....	.....	1	1
Carbuncle.....	.....	2	2
Cerebrospinal fever.....	.....	1	1
Cerebral sclerosis.....	.....	1	1
Cardio-renal disease.....	.....	1	1
Cellulitis, streptococcic.....	1	.....	1
Dysentery, bacillary.....	.....	1	1
Dysentery, unclassified.....	.....	2	2
Endocarditis, acute and chronic.....	.....	3	3
Epithelioma of esophagus.....	.....	1	1
Fever:			
Malarial, estivoautumnal.....	1	3	4
Typhoid.....	.....	4	4
Heart, organic disease of.....	1	14	15
Hemoglobinuric fever, unqualified.....	1	.....	1
Intestinal obstruction.....	1	1	2
Infective exhaustive psychosis.....	.....	1	1
Kidneys, disease of.....	.....	1	1
Liver, cirrhosis of.....	1	.....	1
Manic depressive psychosis.....	.....	1	1
Meningitis:			
Pneumococcus.....	.....	1	1
Tuberculous.....	.....	1	1
Nephritis, chronic.....	.....	19	19
Pellagra.....	.....	1	1
Peritonitis, simple.....	1	1	2
Pneumonia.....	.....	1	1
Pneumonia, lobar.....	2	36	38
Pyelo-nephrosis.....	.....	1	1
Pyelitis.....	.....	1	1
Senility.....	1	.....	1
Septicemia, purulent infection of.....	.....	1	1
Syphilis:			
Tertiary.....	.....	1	1
Secondary.....	.....	1	1
Tetanus.....	.....	2	2
Tuberculosis:			
Abdominal.....	.....	1	1
Disseminated.....	1	12	13
Miliary.....	.....	5	5
Pulmonary.....	1	10	11
Of Psoas muscle and pelvic lymph nodes.....	.....	1	1
Uremia.....	.....	2	2
Ulcer, duodenal.....	.....	1	1
Undiagnosed.....	.....	2	2
<i>External causes.</i>			
Accidental traumatism, various.....	3	16	19
Drowning, accidental.....	3	20	23
Dynamite explosions.....	.....	2	2
Electrocution, accidental.....	.....	1	1
Railroad accidents.....	.....	8	8
Suicide.....	.....	1	1
Other external violence.....	.....	2	2
Total.....	21	202	223

TABLE V.—DEATH RATES AMONG AMERICANS ON THE ISTHMUS.

	Number of deaths.	Annual average per 1,000.
Average number of white employees from the United States (4,180):		
Disease.....	10	2.39
External causes.....	5	1.20
All causes.....	15	3.59
Average number of white women and children from the United States (3,447):		
Disease.....	18	5.22
External causes.....		
All causes.....	18	5.22
Average number of white employees and their families from the United States (7,627):		
Disease.....	28	3.67
External causes.....	5	.66
All causes.....	33	4.33
Average number of all Americans on the Canal Zone (14,823): <sup>1</sup>		
Disease.....	36	2.43
External causes.....	12	.81
All causes.....	48	3.24

<sup>1</sup>Total number of Americans on the Canal Zone includes employees and their families and the officers and enlisted men of the United States Army stationed on the Isthmus.

TABLE VI.—CAUSES OF DEATHS OF CIVIL POPULATION (EMPLOYEES AND NON-EMPLOYEES) AND MILITARY AND PLACES WHERE CHARGEABLE.

	Diseases.	Panama.	Colon.	Canal Zone.	Total.
<i>I. General diseases.</i>					
1	Typhoid fever.....	11	3	1	15
	Malarial fever:				
4a	Estivoautumnal.....	12	7	12	31
4b	Tertian.....	2		1	3
4c	Undetermined.....		1		1
4g	Cachexia.....	1	1		2
5a	Variceloid.....	1			1
6	Measles.....	8	4		12
8	Whooping cough.....	1	3		4
9	Diphtheria and croup.....	3	4	1	8
9a	Croup.....		5		5
9b	Diphtheria bacillus carrier.....		1		1
14	Dysentery.....	7	1		8
14b	Dysentery, bacillary.....		2		2
14c	Dysentery, unclassified.....		2	1	3
18	Erysipelas.....	1			1
19B	Chicken pox.....		1		1
19E	Hemoglobinuric fever, unqualified.....			1	1
19I	Yaws.....	1			1
20	Purulent infection and septicemia.....	4	1	1	6
20a	Pyemia.....	2	1	1	4
20b	Septicemia.....	8	2	1	11
24	Tetanus.....	7	2	1	10
26	Pellagra.....	27	10	3	40
27	Beriberi.....	3	2		5
28	Tuberculosis of the lungs.....	223	61	19	303
29	Acute miliary tuberculosis.....	8	2	5	15
30	Tuberculous meningitis.....	12	4		16
31	Abdominal tuberculosis.....	4	1	1	6
32	Pott's disease.....		1		1
	Tuberculosis:				
33a	Of bones and joints.....	1			1
34	Of other organs.....	3		1	4
34d	Of the genito-urinary organs.....	1			1
35	Disseminated.....	40	14	12	66
36	Rickets.....	1	3		4
	Syphilis:				
37A	Primary.....	1			1
37B	Secondary.....	1			1
37C	Tertiary.....	7	2	2	11
37D	Hereditary.....	7	2		9
37E	Period not stated.....	7	1		8
38Ab	Gonorrheal arthritis.....		1		1
	Cancer and other malignant tumors:				
39	Of the buccal cavity.....	6	2		8
40	Of the stomach and liver.....	3	2		5
41	Of the peritoneum, intestines and rectum.....	3	1		4
42	Of the female genital organs.....	5	1		6

TABLE VI.—CAUSES OF DEATHS OF CIVIL POPULATION (EMPLOYEES AND NON-EMPLOYEES) AND MILITARY AND PLACES WHERE CHARGEABLE—Continued.

	Diseases.	Panama.	Colon.	Canal Zone.	Total.
<i>I. General diseases—Continued.</i>					
Cancer and other malignant tumors—Continued.					
43	Of the breast.....	1	1	.....	2
45	Of other organs and of organs not specified.....	6	2	1	9
47	Acute articular rheumatism.....	1	.....	.....	1
48	Chronic rheumatism and gout.....	1	.....	.....	1
50A	Diabetes.....	.....	1	1	2
53	Leukemia.....	1	.....	.....	1
Anemia:					
54	Chlorosis.....	.....	1	.....	1
54b	Primary, pernicious.....	2	2	.....	4
54c	Secondary, cause not determined.....	6	2	.....	8
55	Other general diseases.....	1	.....	.....	1
Alcoholism:					
56	Acute or chronic.....	4	2	2	8
56a	Acute.....	7	1	1	9
56b	Chronic.....	4	1	1	6
56c	Alcoholic psychosis.....	3	1	1	5
59a	Drug habit.....	.....	1	.....	1
<i>II. Disease of the nervous system and of the organs of special sense.</i>					
60	Encephalitis.....	1	.....	.....	1
61	Simple meningitis.....	10	1	2	13
61b	Pneumococcus meningitis.....	6	.....	3	9
62	Locomotor ataxia.....	1	.....	.....	1
63	Other diseases of the spinal cord.....	2	.....	.....	2
63a	Acute anterior poliomyelitis.....	1	.....	.....	1
64	Cerebral hemorrhage, apoplexy.....	21	16	7	44
65	Softening of the brain.....	2	1	1	4
66	Paralysis without specified cause.....	3	1	1	5
67	General paralysis of the insane.....	3	.....	1	4
68	Other forms of mental alienation.....	4	.....	1	5
69	Epilepsy.....	3	7	.....	10
70	Convulsions (nonpuerperal) (5 years and over).....	1	.....	2	3
71	Convulsions of infants (under 5 years of age).....	5	3	5	13
74	Other diseases of the nervous system.....	1	1	.....	2
74a	Tumor of the brain.....	4	.....	.....	4
76	Diseases of the ears.....	5	.....	1	6
<i>III. Diseases of the circulatory system.</i>					
77	Pericarditis.....	4	2	.....	6
78	Acute endocarditis.....	10	6	1	17
78a	Malignant endocarditis.....	2	1	1	4
79	Organic diseases of the heart.....	76	36	19	131
80	Angina pectoris.....	2	.....	.....	2
81	Diseases of the arteries, atheroma, aneurysm, etc.....	1	.....	.....	1
81a	Aneurysm.....	2	3	5	10
81b	Arteriosclerosis.....	21	5	3	29
82	Embolism and thrombosis.....	2	.....	.....	2
84	Diseases of the lymphatic system (lymphangitis, etc.).....	3	.....	1	4
84a	Lymphadenitis (nonvenereal).....	1	.....	.....	1
85	Hemorrhage, other diseases of the circulatory system.....	3	.....	1	4
<i>IV. Diseases of the respiratory system.</i>					
86b	Myiasis of nasal fossae and sinuses.....	1	.....	1	2
89	Acute bronchitis.....	57	60	3	120
90	Chronic bronchitis.....	10	12	1	23
91	Broncho-pneumonia.....	110	37	35	182
92A	Pneumonia (unqualified).....	29	8	.....	37
92B	Lobar pneumonia.....	51	38	26	115
93A	Pleurisy.....	3	1	.....	4
93B	Empyema.....	3	.....	.....	3
94	Pulmonary congestion, pulmonary apoplexy.....	5	.....	.....	5
95	Gangrene of the lungs.....	1	1	1	3
96	Asthma.....	5	.....	.....	5
97	Pulmonary emphysema.....	1	2	.....	3
98	Other diseases of the respiratory system (tuberculosis excepted).....	3	.....	.....	3
98a	Abscess of lungs.....	.....	.....	1	1
<i>V. Diseases of the digestive system.</i>					
99	Diseases of the mouth and annexe.....	1	.....	.....	1
100	Diseases of the pharynx.....	1	1	.....	2
101	Diseases of the esophagus.....	1	.....	.....	1

TABLE VI.—CAUSES OF DEATHS OF CIVIL POPULATION (EMPLOYEES AND NON-EMPLOYEES) AND MILITARY AND PLACES WHERE CHARGEABLE—Continued.

	Diseases.	Panama.	Colon.	Canal Zone.	Total.
<i>V. Diseases of the digestive system—Continued.</i>					
101b	Stricture of the esophagus.....	1	.....	.....	1
102	Ulcer of the stomach.....	1	.....	.....	1
103b	Acute gastritis.....	4	2	.....	6
103c	Chronic gastritis.....	.....	3	.....	3
103d	Acute indigestion.....	2	4	2	8
104	Diarrhea and enteritis (under 2 years).....	244	34	12	290
104a	Colitis.....	56	11	3	70
105	Diarrhea and enteritis (2 years and over).....	21	6	4	31
105a	Colitis.....	5	3	.....	8
106	Ankylostomiasis.....	3	.....	.....	3
108	Appendicitis and typhlitis.....	1	.....	.....	1
108b	Chronic appendicitis.....	.....	.....	1	1
109	Hernia, intestinal obstructions.....	4	1	1	6
109b	Other hernias.....	1	.....	.....	1
109c	Intestinal obstruction.....	6	.....	4	10
110	Other diseases of the intestines.....	4	1	2	7
110b	Duodenal ulcer.....	2	.....	2	4
113	Cirrhosis of the liver.....	7	4	1	12
114	Biliary calculi.....	.....	.....	1	1
115	Other diseases of the liver.....	.....	2	.....	2
115a	Abscess of liver (unqualified).....	6	3	1	10
115	Cholecystitis.....	1	.....	.....	1
116	Diseases of the spleen.....	1	.....	.....	1
117	Simple peritonitis (nonpuerperal).....	8	6	1	15
<i>VI. Nonvenereal diseases of the genito-urinary system.</i>					
119	Acute nephritis.....	22	15	6	43
120	Bright's disease (chronic nephritis).....	74	64	21	159
122	Other diseases of the kidney and annexa.....	7	4	2	13
122c	Pyelo-nephrosis.....	2	2	1	5
124a	Cystitis.....	3	.....	1	4
125	Diseases of the urethra, urinary abscess, etc.....	1	.....	1	2
129	Uterine tumor (noncancerous).....	1	.....	.....	1
130	Other diseases of the uterus.....	2	.....	.....	2
132	Salpingitis and other diseases of the female genital organs.....	1	.....	.....	1
<i>VII. The puerperal state.</i>					
134B	Accidents of pregnancy.....	1	2	.....	3
134Bc	Abortion.....	1	.....	1	2
135	Puerperal hemorrhage.....	1	1	2	4
136	Other accidents of labor.....	2	1	.....	3
137	Puerperal septicemia.....	4	2	3	9
138	Puerperal albuminuria and convulsions.....	2	3	.....	5
138a	Eclampsia.....	3	1	3	7
140	Following childbirth (not otherwise defined).....	.....	.....	2	2
<i>VIII. Diseases of the skin and cellular tissue.</i>					
142	Gangrene.....	3	2	.....	5
143a	Carbuncle.....	2	1	.....	3
144a	Phlegmon and cellulitis.....	1	.....	.....	1
145E	Pemphigus contagious.....	1	.....	.....	1
145O	Tropical ulcer.....	1	.....	.....	1
<i>IX. Diseases of the bones and of the organs of locomotion.</i>					
146	Diseases of the bones (tuberculosis excepted).....	1	.....	.....	1
146c	Osteomyelitis.....	1	.....	.....	1
<i>X. Malformations.</i>					
150	Congenital malformations (stillbirths not included).....	3	.....	2	5
<i>XI. Diseases of early infancy.</i>					
151A	Newborn child.....	1	1	7	9
151B	Congenital debility, icterus, and sclerema.....	2	3	1	6
151Ba	Premature birth.....	34	5	13	52
151Bb	Congenital debility.....	27	6	8	41
151Bd	Malnutrition.....	52	25	30	107
152	Other causes peculiar to early infancy (including various consequences of labor).....	12	4	1	17
153	Lack of care.....	.....	1	.....	1

TABLE VI.—CAUSES OF DEATHS OF CIVIL POPULATION (EMPLOYEES AND NON-EMPLOYEES) AND MILITARY AND PLACES WHERE CHARGEABLE—Continued.

	Diseases.	Panama.	Colon.	Canal Zone.	Total.
	XII. <i>Old age.</i>				
154	Senility.....	3	2	1	6
	XIII. <i>Affections produced by external causes.</i>				
155	Suicide by poisoning.....	3	3		6
157	Suicide by hanging or strangulation.....	1	1		2
159	Suicide by firearms.....	3	1	1	5
163	Other suicides.....			1	1
164	Poisoning by food.....	1		1	2
165	Other acute poisonings.....	2			2
167	Burns (conflagration excepted).....	6		1	7
169	Accidental drowning.....	4	9	24	37
170	Traumatism by firearms.....	2	2	1	5
171	Traumatism by cutting or piercing instruments.....	1			1
172	Traumatism by fall.....	5	1	7	13
174	Traumatism by machines.....	4	1	2	7
175	Traumatism by other crushings (vehicles, railroads, etc.).....	4	4	3	11
175a	Railroad traumatism.....	4	2	3	9
175b	Dynamite traumatism.....			3	3
177	Starvation.....	1			1
181	Electricity (lightning excepted).....			1	1
182	Homicide by firearms.....	5	3	1	9
183	Homicide by cutting or piercing instruments.....		1	1	2
184	Homicide by other means.....	1		1	2
185A	Fractures (cause not specified).....	1	1		2
186	Other external violence.....	11		1	12
	XIV. <i>Ill-defined diseases.</i>				
187	Ill-defined organic disease.....	2		2	4
188	Sudden death.....	1	2		3
189A	Cause of death not specified or ill defined.....	47	24	6	77
189Aa	Infections of undetermined origin.....	2	2	3	7
	Total.....	1,710	691	398	2,799
	Stillbirths.....	184	57	49	290
	Grand total.....	1,894	748	447	3,089

TABLE VII.—ADMISSIONS AND DEATHS OF EMPLOYEES AND SOLDIERS IN THE HOSPITALS OF THE PANAMA CANAL, FROM ALL CAUSES, FOR THE FISCAL YEAR 1915-16.

	Diseases.	Employees.				Soldiers.	
		Admissions.		Deaths.		Admissions.	Deaths.
		White.	Black.	White.	Black.		
	I. <i>General diseases.</i>						
1	Typhoid fever.....	1	5	5			
3	Relapsing fever.....	1					
4	Malaria.....		1				
	Malarial fever:						
4a	Estivoautumnal.....	134	423	1	5	158	
4b	Tertian.....	49	95			61	
4c	Quartan.....	1	3			2	
4e	Undetermined.....	1					
4f	Clinical.....	81	189			107	
4g	Cachexia.....					1	
4h	Hemoglobinuric fever, malarial.....	1	1				
5b	Vaccinia.....			3			
6	Measles.....	6	63			7	
9	Diphtheria and croup.....	8	21			4	
10	Influenza.....	43	56			23	
14	Dysentery.....	3	5				
14a	Entamoebic.....	4	5			7	
14b	Bacillary.....	1	1		1	1	
14c	Unclassified.....	1	7		2		
17	Leprosy.....		4				



TABLE VII.—ADMISSIONS AND DEATHS OF EMPLOYEES AND SOLDIERS IN THE HOSPITALS OF THE PANAMA CANAL, FROM ALL CAUSES, FOR THE FISCAL YEAR 1915-16—Continued.

Diseases.		Employees.				Soldiers.	
		Admissions.		Deaths.		Admissions.	Deaths.
I. General diseases—Continued.							
18	Erysipelas.....	6	2				
19A	Dengue.....	4					
19B	Chicken pox.....	1	20			1	
19D	Mumps.....	1	63			5	
19E	Hemoglobinuric fever, unqualified.....	1	2	1			
19I	Yaws.....		2				
19J	Kala-azar.....	1					
19L	Malta fever.....					1	
19M	Acute infectious jaundice.....	2	1			3	
19O	Other epidemic diseases.....					1	
20	Purulent infection and septicemia.....	2			1		
20b	Septicemia.....	1					
20c	Pyemia and septicemia, pneumococcic.....					1	
22	Anthrax.....		2				
24	Tetanus.....		3		2		
26	Pellagra.....		7		1		
27	Beriberi.....		2				
28	Tuberculosis of the lungs.....	24	83	1	9	3	1
29	Acute miliary tuberculosis.....		8		5		
30	Tuberculous meningitis.....		1		1		
21	Abdominal tuberculosis.....		2		1		
	Tuberculosis:						
33a	Of bones and joints.....		3			1	
34	Of other organs.....				1		
34c	Of the lymph glands.....					3	
34e	Tuberculous abscess.....		1				
35	Disseminated tuberculosis.....		6	1	16		
	Syphilis:						
37A	Primary.....	4	15			12	
37B	Secondary.....	12	41			52	
37C	Tertiary.....	9	135		1	14	
37D	Hereditary.....	1	4				
37E	Period not stated.....	3	31			12	
38A	Gonococcus infection.....	8	18			12	
38Aa	Gonorrhea.....	28	94			84	
	Gonorrheal:						
38Ab	Arthritis.....	2	7				
38Ac	Bubo.....		5			4	
38Ad	Orchitis and epididymitis.....	3	31			12	
38Ee	Ophthalmia.....		6				
38B	Soft chancre.....	21	68			72	
38Ba	Adenitis chancroidal.....	5	24			14	
	Cancer and other malignant tumors:						
40	Of the stomach and liver.....	5	2		2		
41	Of the peritoneum, intestines, and rectum.....		3				
44	Of the skin.....		1				
45	Of other organs and of organs not specified.....		1				
46	Other tumors (tumors of the female genital organs excepted).....	4	5			8	
47	Acute articular rheumatism.....		7				
48	Chronic rheumatism and gout.....	4	9			3	
50A	Diabetes.....	4	3			1	1
51	Exophthalmic goiter.....	1					
53b	Hodgkin's disease.....		2				
54c	Anemia secondary, cause not determined.....	1	5		2	1	
55	Other general diseases.....	1	2				
55a	Serum disease.....		1				
55b	Purpura hemorrhagica.....	1				1	
	Alcoholism:						
56	Acute or chronic.....					2	
56a	Acute.....	6	2	1		22	
56b	Chronic.....	5				7	
56c	Alcoholic psychosis.....	1	2			3	
58	Other chronic occupation poisonings.....			1			
59a	Drug habit.....					1	
II. Diseases of the nervous system and of the organs of special sense.							
61	Simple meningitis.....		1		1	1	1
61b	Pneumococcus meningitis.....		1		1		

TABLE VII.—ADMISSIONS AND DEATHS OF EMPLOYEES AND SOLDIERS IN THE HOSPITALS OF THE PANAMA CANAL, FROM ALL CAUSES, FOR THE FISCAL YEAR 1915-16—Continued.

	Diseases.	Employees.				Soldiers.	
		Admissions.		Deaths.		Admissions.	Deaths.
		White.	Black.	White.	Black.		
	<i>II. Diseases of the nervous system and of the organs of special sense—Continued.</i>						
62	Locomotor ataxia.....					1	
63a	Acute anterior poliomyelitis.....		1				
64	Cerebral hemorrhage, apoplexy.....		3		2		
65	Softening of the brain.....				1		
66	Paralysis without specified cause.....		2			1	
67	General paralysis of the insane.....					2	
68	Other forms of mental alienation.....	1	5		2	10	
68a	Dementia precox.....	1	5			11	
69	Epilepsy.....	2	6				
73A	Hysteria.....	1	1				
73B	Neuralgia.....	3	1				
73C	Neuritis.....	14	14			16	
74	Other diseases of the nervous system.....	7	6		1	11	
74a	Tumor of the brain.....					1	
74b	Neurasthenia.....	16	2			33	
75	Diseases of the eyes and their annexa.....	42	127			48	
75a	Follicular conjunctivitis.....		1			1	
75b	Trachoma.....					1	
76	Diseases of the ears.....	19	16			43	
78	Acute endocarditis.....	1				3	
78a	Malignant endocarditis.....		3		3		
79	Organic diseases of the heart.....	19	36	1	4	4	
80	Angina pectoris.....					2	
81	Diseases of the arteries, atheroma, aneurysm, etc.....	3	3				
81a	Aneurysm.....	1	2		2		
81b	Arterio-sclerosis.....	2	6				
83	Diseases of the veins (varices, hemorrhoids, phlebitis, etc.).....	8	3			15	
83a	Hemorrhoids.....	16	22			26	
83b	Varices.....		3				
83c	Varicocele.....	4				19	
83d	Phlebitis.....		2				
84	Diseases of the lymphatic system (lymphangitis, etc.).....	7	6			5	
84a	Lymphadenitis (nonvenereal).....	14	35			42	
85	Hemorrhage; other diseases of the circulatory system.....	1	1				
	<i>IV. Diseases of the respiratory system.</i>						
86	Diseases of the nasal fossae.....	19	4			46	
86b	Myiasis of nasal fossae and sinuses.....		1			3	
87	Diseases of the larynx.....		2				
87a	Laryngitis.....		3				
88	Diseases of the thyroid body.....					1	
89	Acute bronchitis.....	32	51			12	
90	Chronic bronchitis.....	11	17			3	
91	Broncho-pneumonia.....		19		4		
92A	Pneumonia (unqualified).....		8				
92B	Lobar pneumonia.....	5	88	2	33	1	
93A	Pleurisy.....	9	48			2	
93B	Empyema.....		3				
96	Asthma.....	8	10				
98	Other diseases of the respiratory system (tuberculosis excepted).....	2					
98a	Abscess of lungs.....	1				2	1
	<i>V. Diseases of the digestive system.</i>						
99	Diseases of the mouth and annexa.....	1	3			1	
99a	Diseases of the teeth and gums.....	6	10			4	
99b	Stomatitis.....	2	3			1	
100	Diseases of the pharynx.....	8	11			22	
100a	Pharyngitis.....	2	2			1	
100b	Follicular tonsillitis.....	51	36			51	
101	Diseases of the esophagus.....	1					
101b	Stricture of the esophagus.....					1	
102	Ulcer of the stomach.....	10	2			7	1
103	Other diseases of the stomach (cancer excepted).....	4	2			2	

TABLE VII.—ADMISSIONS AND DEATHS OF EMPLOYEES AND SOLDIERS IN THE HOSPITALS OF THE PANAMA CANAL, FROM ALL CAUSES, FOR THE FISCAL YEAR 1915-16—Continued.

Diseases.		Employees.				Soldiers.	
		Admissions.		Deaths.		Admissions.	Deaths.
		White.	Black.	White.	Black.		
V. <i>Diseases of the digestive system—Contd.</i>							
103a	Gastrectasis .....					1	
	Gastritis:						
103b	Acute .....	8	2			3	
103c	Chronic .....	1	1				
103d	Acute indigestion .....	11	6			5	
104a	Colitis .....	2	7			1	
105	Diarrhea and enteritis (over 2 years) .....	17	22			9	
105a	Colitis .....	1	9			2	
106	Ankylostomiasis .....		6				
107	Intestinal parasites .....	3	5			1	
107e	Teniasis .....	2				1	
108	Appendicitis and typhilitis .....		1				
	Appendicitis:						
108a	Acute .....	21	6			34	
108b	Chronic .....	16	3			9	1
109a	Inguinal hernia .....	38	73			34	
109b	Other hernias .....	4	1			2	
109c	Intestinal obstruction .....			1		3	
110	Other diseases of the intestines .....	55	19			39	
110a	Constipation .....	11	7			14	
110b	Duodenal ulcer .....	4	4		1	3	
113	Cirrhosis of the liver .....	2	2	1			
114	Biliary calculi .....	3	1			1	
115	Other diseases of the liver .....	8	2			4	
	Abscess of liver:						
115a	Unqualified .....	1	2				
115b	Entamebic .....	2					
115c	Cholecystitis .....	6	2			1	
117	Simple peritonitis (nonpuerperal) .....	1		1			
118	Other diseases of the digestive system (cancer and tuberculosis excepted) .....		4			1	
VI. <i>Nonvenereal diseases of the genito-urinary system and annexa.</i>							
119	Acute nephritis .....	6	2			2	
120	Bright's disease (chronic nephritis) .....	4	59	1	17	1	
122	Other diseases of the kidney and annexa .....	5	4		1	4	
122a	Bilharziosis of urinary tract .....						
122c	Pyelonephrosis .....		4		1	2	
123	Calculi of the urinary passages .....	12	2			5	
124	Diseases of the bladder .....		2				
124a	Cystitis .....	12	3			2	
125	Diseases of the urethra, urinary abscess .....	6	14			2	
125a	Stricture of the urethra, nonvenereal .....	2	16			4	
	Prostatitis:						
126a	Acute .....					1	
126b	Chronic .....	5				3	
126c	Abscess of the prostate .....		1				
126d	Hypertrophy of prostate .....	1	1			1	
127	Nonvenereal diseases of the male genital organs .....	13	39			12	
127a	Hematocele .....					1	
127b	Hydrocele .....	5	13			4	
127d	Lymph scrotum and varix .....		3				
128	Uterine hemorrhage (nonpuerperal) .....	1					
129	Uterine tumor (noncancerous) .....		3				
130	Other diseases of the uterus .....	8	1				
132	Salpingitis and other diseases of the female genital organs .....		2				
133	Nonpuerperal diseases of the breast (cancer excepted) .....	1	1				
VII. <i>The puerperal state.</i>							
134A	Normal labor .....	1					
134B	Accidents of pregnancy .....	1					
134Bb	Hyperemesis gravidarum .....	1					
134Bc	Abortion .....	1					
135	Puerperal hemorrhage .....	2					
138	Puerperal albuminuria and convulsions .....	0					
140	Following childbirth (not otherwise defined) .....	1					

TABLE VII.—ADMISSIONS AND DEATHS OF EMPLOYEES AND SOLDIERS IN THE HOSPITALS OF THE PANAMA CANAL, FROM ALL CAUSES, FOR THE FISCAL YEAR 1915-16—Continued.

	Diseases.	Employees.				Soldiers.	
		Admissions.		Deaths.		Admissions.	Deaths.
		White.	Black.	White.	Black.		
	VIII. <i>Diseases of the skin and of the cellular tissue.</i>						
142	Gangrene.....		2			1	
143	Furuncle.....	11	3			3	
143a	Carbuncle.....	8	3		1	2	
144	Acute abscess.....	21	40			13	
144a	Phlegmon and cellulitis.....	21	32			17	
145B	Scabies.....	2	1				
145E	Pemphigus contagious.....					1	
145I	Elephantiasis.....		2				
145K	Dhobie itch.....	6				6	
145M	Ulcer of the skin.....	8	6			3	
145O	Tropical ulcer.....		1				
145Q	Impetigo contagiosa.....	3					
145R	Ingrowing nail.....	10	1			13	
145T	Other diseases of the skin and annexa.....	12	18			27	
	IX. <i>Diseases of the bones and of the organs of locomotion.</i>						
146	Diseases of the bones (tuberculosis excepted).....	15	18			10	
146a	Caries (nontuberculosis).....	1					
146b	Mastoid abscess.....		1				
146c	Osteomyelitis.....		4			4	
146d	Periostitis.....	1	2			1	
147	Diseases of the joints (tuberculosis and rheumatism excepted).....	1	2			2	
147b	Arthritis.....	3	34			7	
147c	Synovitis.....	6	1			2	
148	Amputations.....	2	13			1	
149	Other diseases of the organs of locomotion.....	29	17			19	
	X. <i>Malformations.</i>						
150	Congenital malformations (stillbirths not included).....	2	2			2	
	XII. <i>Old age.</i>						
154	Senility.....	1	1	1			
	XIII. <i>Affections produced by external causes.</i>						
160	Suicide by cutting or piercing instruments.....		1			3	
163	Other suicides.....		1				
164	Poisoning by food.....	29	17			6	
165	Other acute poisonings.....	6	3			5	
165b	Snake bites.....	1	1				
166	Conflagration.....		2				
167	Burns (conflagration excepted).....	9	35		1		
	Traumatism:						
170	By firearms.....		4			18	1
171	By cutting or piercing instruments.....	25	161			9	
172	By fall.....	18	74	1	5	19	1
173	In mines and quarries.....	1	12				
174	By machines.....	11	63			2	
175	By other crushings.....	24	203		2	2	
175a	Railroad.....	2	21		2		
175b	Dynamite.....		5		2		
175c	By handslides.....		10				
176	Injuries by animals.....		4			5	
177	Starvation.....	1					
177b	Heat exhaustion.....	1	2				
181	Electricity (lightning excepted).....		1				
185A	Fractures (cause not specified).....	27	102		1	30	
185B	Dislocations.....	6	11			7	
185C	Sprains.....	18	41			4	
186	Other external violence.....	85	267			62	
	XIV. <i>Ill-defined diseases.</i>						
187	Ill-defined organic disease.....	1	3		1	2	
189A	Cause of death not specified or ill defined.....	1	1		1		
189Aa	Infections of undetermined origin.....	11	33			14	
189Ba	No disease.....	14	14			18	
189Bb	Feigned disease.....	2	3			1	
	Total.....	1,619	3,908	15	143	1,739	9

TABLE VIII.—CONSOLIDATED HOSPITAL REPORT.

	Remain- ing July 1.		Admitted.		Died.		Discharged.		Trans- ferred.		Remain- ing June 30.	
	White.	Colored.	White.	Colored.	White.	Colored.	White.	Colored.	White.	Colored.	White.	Colored.
<b>ANCON HOSPITAL.</b>												
Panama Canal employees.....	41	173	1,092	2,168	12	64	1,085	2,133	4	26	32	118
Panama Railroad employees.....	7	64	154	939	2	42	148	894	2	12	9	55
Panama pay patients.....			2	10					2	7		1
Other pay patients.....	139	36	3,350	1,202	38	112	3,293	1,064	24	13	134	49
Charity patients.....	9	33	263	366	10	52	252	293	3	19	7	35
Total.....	196	306	4,861	4,685	62	272	4,778	4,384	35	77	182	258
<b>Insane department:</b>												
Panama Canal employees.....	5	10	3	4		2	1	2	2		5	10
Panama Railroad employees.....		2	1	7		2	1	1		1		5
Panama pay patients.....	13	164	27	85	1	27	5	38	1	12	33	172
Other pay patients.....	6	2	28	10	1	5	24	6	1		8	1
Charity patients.....	7	44	2	21		5		8		4	9	48
Total.....	31	222	61	127	2	41	31	55	4	17	55	236
Grand total.....	227	528	4,922	4,812	64	313	4,809	4,439	39	94	237	494
Corozal farm; Panama Canal employees.....	9	40	6	31			5	27			10	44
Chronic ward; Charity patients.....		26		25				19		4		28
<b>COLON HOSPITAL.</b>												
Panama Canal employees.....	4	8	275	354	2	7	238	254	32	99	7	2
Panama Railroad employees.....		9	95	436		29	78	272	15	133	2	11
Panama pay patients.....			31	188		14	3	23	26	151	1	
Other pay patients.....	8	5	364	158	5	7	283	122	77	31	7	3
Charity patients.....		2	34	67	1	3	25	37	8	29		
Total.....	12	24	799	1,203	9	60	627	708	158	443	17	16
<b>PALO SECO LEPER ASYLUM.</b>												
Panama Canal employees.....				3								3
Panama pay patients.....	3	33		7	1	3					2	37
Charity patients.....	2	18		3							2	21
Total.....	5	51		13	1	3					4	61
<b>GRAND TOTALS.</b>												
Panama Canal employees.....	59	231	1,376	2,560	14	73	1,329	2,416	38	125	54	177
Panama Railroad employees.....	7	75	250	1,382	2	73	227	1,167	17	146	11	71
Panama pay patients.....	16	197	60	290	3	46	8	61	29	170	36	210
Other pay patients.....	153	43	3,742	1,370	44	124	3,600	1,192	102	44	149	53
Charity patients.....	18	123	299	482	11	60	277	357	11	56	18	132
Total.....	253	669	5,727	6,084	74	376	5,441	5,193	197	541	268	643

TABLE IX.—CONSOLIDATED REPORT OF EMPLOYEES TREATED IN QUARTERS.

Stations.	Remain- ing July 1.		Admitted.		Died.		Discharged.		Trans- ferred.		Remain- ing June 30.	
	White.	Colored.	White.	Colored.	White.	Colored.	White.	Colored.	White.	Colored.	White.	Colored.
Naos Island.....			1				1					
Ancon.....	14		1,441	4			1,427	4	28			
Balboa.....	6	1	934	436			854	245	83	192	3	
Corozal.....	3		87	3			89	10	1	1		
Pedro Miguel.....	3		162	3			156	2	9			
Paraiso.....		1	273	187			249	152	23	36	1	
Gamboa.....			4	16			1	14	2	2	1	
Gatun.....	2	2	161	83			157	78	4	6	2	1
Colon.....	6	21	895	609			894	612	1	6	6	17
Total.....	34	25	3,963	1,349			3,828	1,117	156	239	13	18

TABLE IX.—CONSOLIDATED REPORT OF EMPLOYEES TREATED IN QUARTERS—Con.  
CONSOLIDATED REPORT OF DAYS LOST IN QUARTERS.

Stations.	White.	Colored.	Total.
Naos Island.....	2	.....	2
Ancon.....	3,323	124	3,447
Balboa.....	2,486	1,175	3,661
Corozal.....	321	24	345
Pedro Miguel.....	441	8	449
Paraiso.....	678	524	1,202
Gamboa.....	11	25	36
Gatun.....	556	460	1,016
Colon.....	2,384	4,816	7,200
Total.....	10,202	7,156	17,358

TABLE X.—CONSOLIDATED HOSPITAL AND EMPLOYEES TREATED IN QUARTERS  
REPORT.

	Remain- ing July 1.		Admitted.		Died.		Discharged.		Trans- ferred.		Remain- ing June 30.	
	White.	Colored.	White.	Colored.	White.	Colored.	White.	Colored.	White.	Colored.	White.	Colored.
Hospitals.....	253	669	5,727	6,084	74	376	5,441	5,193	197	541	268	643
Quarters.....	34	25	3,963	1,349	.....	.....	3,828	1,117	156	239	13	18
Total.....	287	694	9,943	8,102	74	376	9,269	6,310	353	780	281	661

	White.	Colored.	Total.
Total admissions to hospitals, excluding Corozal farm and chronic ward...	5,721	6,028	11,749
Total admissions of employees to quarters.....	3,963	1,349	5,312
Total.....	9,684	7,377	17,061
Less number of patients transferred from quarters to hospitals, and between hospitals, whose admissions are duplicated in above figures.....	353	776	1,129
Net admissions to hospitals and quarters.....	9,331	6,601	15,932
Net admissions of employees to hospitals and quarters.....	5,372	4,729	10,101
Annual average per thousand of admissions of employees to hospitals and quarters.....	1,169.86	163.32	301.09

CONSOLIDATED DISPENSARY REPORT OF ALL CASES TREATED BUT NOT EXCUSED.

Stations.	Employees.			Nonemployees.			Totals.		
	White.	Colored.	Total.	White.	Colored.	Total.	White.	Colored.	Total.
Naos Island.....	532	1,332	1,864	.....	.....	.....	532	1,332	1,864
Ancon.....	29,347	45,189	74,536	19,895	27,415	47,310	49,242	72,604	121,846
Balboa.....	39,583	45,181	84,764	10,277	8,993	19,270	49,860	54,178	104,038
Corozal.....	4,572	5,465	10,037	2,750	812	3,562	7,332	6,277	13,609
Pedro Miguel.....	8,102	12,035	20,137	8,193	3,268	11,461	16,295	15,303	31,598
Paraiso.....	10,507	31,678	42,185	6,982	10,245	17,227	17,489	41,923	59,412
Gamboa.....	458	1,662	2,120	250	4,560	4,810	708	6,222	6,930
Gatun.....	6,600	20,972	27,572	13,885	16,490	30,375	20,485	37,462	57,947
Colon.....	12,193	32,058	44,251	8,377	10,818	19,195	20,570	42,876	63,446
Total.....	111,894	195,572	307,466	70,609	82,601	153,210	182,513	278,177	460,690

TABLE XI.—AVERAGE NUMBER OF EMPLOYEES CONSTANTLY SICK IN HOSPITALS AND QUARTERS.

## HOSPITALS.

	White.	Colored.	Total.
Ancon Hospital.....	50.60	216.01	266.61
Colon Hospital.....	8.36	15.04	23.40
Palo Seco Leper Asylum.....		.39	.39
Total.....	58.96	231.44	290.40

## QUARTERS.

Naos Island.....			
Ancon.....	9.10	0.34	9.44
Balboa.....	6.81	3.22	10.03
Corozal.....	.88	.07	.95
Pedro Miguel.....	1.21	.02	1.23
Paraíso.....	1.86	1.43	3.29
Gamboa.....	.03	.07	.10
Gatun.....	1.52	1.26	2.78
Colon.....	6.53	13.20	19.73
Total.....	27.94	19.61	47.55

## AVERAGE NUMBER OF EMPLOYEES CONSTANTLY SICK.

Hospitals.....	58.96	231.44	290.40
Quarters.....	27.94	19.61	47.55
Total.....	86.90	251.05	337.95

## AVERAGE NUMBER OF EMPLOYEES CONSTANTLY SICK PER 1,000.

Hospitals.....	12.84	7.99	8.66
Quarters.....	6.08	.68	1.42
Total.....	18.92	8.67	10.08

TABLE XII.—AVERAGE LENGTH OF STAY IN HOSPITALS OR QUARTERS FOR EACH ADMISSION OF SICK EMPLOYEES.

	White.	Colored.	Total.
Hospitals:			
Ancon Hospital.....	14.69	24.80	21.94
Colon Hospital.....	8.36	6.92	7.37
Total (average).....	13.27	21.26	18.95
Quarters:			
Naos Island.....	2.00		2.00
Ancon.....	2.28	31.00	2.36
Balboa.....	2.65	2.69	2.66
Corozal.....	3.57	2.18	3.41
Pedro Miguel.....	2.66	2.67	2.66
Paraíso.....	2.45	2.79	2.58
Gamboa.....	3.67	1.56	1.89
Gatun.....	3.45	5.48	4.15
Colon.....	2.66	7.86	4.77
Total (average).....	2.56	5.28	3.25

TABLE XIII.—SUBSISTENCE AND OPERATING EXPENSES.

Subsistence expenses:		
Number of days' rations issued to patients.....		318,302
Cost of rations issued to patients.....	\$73,185.94	
Cost of subsistence per patient per day.....	\$0.230	
Operating expenses:		
Number of days' relief furnished patients in hospitals.....		318,302
Cost of operations of hospitals.....	\$417,994.63	
Cost per patient per day.....	\$1.407	
Cost of operation with amount received from outside patients, etc., deducted.....	\$197,534.73	
Cost per capita per day with above deduction.....	\$0.621	
Cost of dispensaries.....	\$34,410.46	

## FINANCIAL STATEMENT.

	Health department expenditures, fiscal year 1914-15.	Health department expenditures, fiscal year 1915-16.
Administration <sup>1</sup> .....	\$10,504.08	.....
Medical storehouse <sup>1</sup> .....	4,237.10	.....
Ancon Hospital.....	404,894.90	\$323,552.03
Colon Hospital.....	42,006.35	47,914.00
Santo Tomas Hospital.....	11,131.87	11,136.23
Dispensaries <sup>2</sup> .....	75,529.96	44,646.35
Quarantine service.....	51,975.87	61,957.47
Sanitation proper, Panama.....	37,556.63	47,523.73
Disposal of garbage, street cleaning, Panama.....	54,060.41	53,224.65
Sanitation proper, Colon.....	28,014.87	38,409.57
Disposal of garbage, street cleaning, Colon.....	23,675.14	27,301.51
Sanitation, Canal Zone.....	130,867.07	180,180.92
Construction and repair of buildings.....	14,867.94	.....
Corozal Hospital.....	30,766.59	74,010.35
Palo Seco Leper Asylum <sup>3</sup> .....	.....	23,270.85
Total.....	923,108.78	933,127.66

<sup>1</sup> Cost of administration (chief health office) and of medical storehouse prorated into operating accounts since Jan. 1, 1915.

<sup>2</sup> Cost of dispensaries for 1914-15 included cost of operation of Palo Seco Leper Asylum.

<sup>3</sup> Included under dispensaries for 1914-15.

TABLE XIV.—PATIENTS OTHER THAN EMPLOYEES TREATED IN HOSPITALS, INCLUDING PALO SECO LEPER ASYLUM, AND AMOUNTS RECEIVED FOR THEIR TREATMENT.

	Number of admissions.	Number days' treatment.	Amount.
Paid for by Panama Republic:			
Insane.....	102	68,549	\$51,539.25
Colon Hospital.....	219	371	833.99
Lepers.....	11	14,920	10,132.50
Total.....	332	83,840	62,525.74
For whom department of civil government pays \$2,400 per year (charity).....	693	41,224	2,400.00
Outside pay cases.....	847	12,961	66,259.39
Families of employees, etc.....	2,253	42,370	49,755.29
Soldiers.....	1,738	26,566	45,554.99
Residents of Panama, emergency charity cases.....	21	149	.....
Public health service <sup>1</sup> .....	105	1,831	2,837.99
Total.....	5,989	208,941	229,313.40

<sup>1</sup> Public health service includes only patients admitted during last 6 months; during the first 6 months of the fiscal year they were included under outside pay cases.



TABLE XV.—SURGICAL OPERATIONS PERFORMED IN HOSPITALS.

	Number.	Died.		Number.	Died.
<b>Amputations:</b>			<b>General:</b>		
Shoulder.....	2	1	Thyroidectomy.....	6	.....
Arm.....	1	1	Nerve stretching.....	2	.....
Forearm.....	1	.....	Varicose veins, excision of.....	13	.....
Thigh.....	4	1	Tenorrhaphy.....	16	.....
Leg.....	6	1	Myorrhaphy.....	1	.....
Foot.....	2	.....	Excision of surface neoplasms.....	42	.....
Digits, multiple.....	24	.....	Gun-shot wound of soft parts, operation for.....	2	.....
Arm and leg.....	1	.....	Stab wound of soft parts, operation for.....	3	.....
<b>Operations on bones:</b>			Extensive injuries to soft parts, operation for.....	9	.....
Cranietomy, decompressive.....	5	2	Plastic operation for congenital defect.....	3	.....
Laminectomy.....	2	1	Plastic operation for severe injuries.....	4	.....
Ostelectomy.....	18	.....	Plastic operations for effects of disease.....	5	.....
Arthrotomy of knee joint.....	4	.....	Skin graft.....	16	.....
Wiring of fractures, simple.....	30	.....	<b>Laparotomy:</b>		
Wiring of fractures, compound.....	19	1	For general peritonitis.....	5	3
Bone transplant.....	1	.....	For tuberculous peritonitis.....	7	5
<b>Adenectomy:</b>			For intestinal obstruction.....	11	1
Cervical.....	11	.....	Exploratory.....	8	2
Axillary.....	1	.....	Gastrotomy.....	1	.....
Inguinal, single.....	207	.....	Gastro-enterostomy.....	29	2
Inguinal, double.....	58	.....	Entero-enterostomy.....	3	.....
Femoral.....	15	.....	Enterectomy.....	3	2
<b>Herniotomy:</b>			Appendectomy.....	144	.....
Inguinal, single.....	147	.....	Appendectomy with local peritonitis.....	17	1
Inguinal, double.....	21	.....	Appendectomy with general peritonitis.....	1	1
Femoral.....	1	.....	Cholecystotomy.....	3	.....
Ventral.....	7	.....	Cholecystostomy.....	5	.....
Combined (any two of the above).....	1	.....	Cholecystectomy.....	7	.....
Strangulated.....	5	.....	Abscess of liver, laparohepatotomy for.....	4	2
<b>Genito-urinary tract:</b>			Splenectomy.....	1	.....
Nephrotomy.....	4	.....	Pan-hysterectomy.....	15	1
Nephrectomy.....	1	.....	Supravaginal hysterectomy.....	50	3
Nephropexy.....	2	.....	Hysteromyomectomy.....	29	.....
Ureterotomy.....	2	.....	Myomectomy.....	3	.....
Urethrotomy, internal.....	9	.....	Salpingectomy, single.....	6	.....
Urethrotomy, external.....	18	.....	Salpingectomy, double.....	2	.....
Prostatectomy.....	3	1	Salpingo-oophorectomy.....	17	1
Varicocele, radical cure.....	24	.....	Ovarian cystectomy.....	5	.....
Hydrocele, single, radical cure.....	30	.....	Oophorectomy.....	3	.....
Hydrocele, double, radical cure.....	4	.....	Suspensio-uteri.....	47	.....
Orchidectomy.....	2	.....	Plastic operation for chronic pelvic peritonitis.....	7	.....
Epididymotomy.....	97	.....	For ectopic gestation.....	1	.....
Amputation of the scrotum.....	11	.....	Pylorotomy.....	3	.....
Amputation of the penis.....	1	.....	Gastrectomy.....	3	.....
Curetage uteri.....	103	1	Choledochotomy.....	3	.....
Perineoplasty.....	11	.....	<b>For trauma:</b>		
Trachelorrhaphy.....	9	.....	General peritonitis.....	1	1
/aginal puncture.....	1	.....	Rupture of spleen.....	1	.....
<b>Obstetrical:</b>			Gunshot wound of abdomen.....	1	1
Cæsarian section, abdominal.....	4	1	Major operations, various others.....	117	1
Accouchement forcé.....	2	2	Minor operations, various others.....	1,585	12
Low forceps.....	9	.....	Total.....	3,338	41
Version.....	6	1			
Perineorrhaphy.....	11	.....			
<b>Thorax:</b>					
Thoracotomy.....	8	2			
Excision of breast and axilla.....	3	.....			
Excision of breast.....	1	.....			
<b>Rectum:</b>					
Hemorrhoids, radical cure.....	92	.....			
Fistula in anus, excision of.....	14	.....			
Prolapsus rectum, radical excision.....	1	.....			

<sup>1</sup> Streptococcus septicemia, 1; carbuncle, 1.

TABLE XVI.—OPERATIONS AND WORK PERFORMED IN EYE, EAR, NOSE, AND THROAT CLINICS.

Operations.	Number.	Died.	Operations.	Number.	Died.
Adenoidectomy.....	148	.....	Plastic on eyelid.....	1	.....
Advancement of internal rectus.....	2	.....	Plastic, face.....	2	.....
Antral sinusotomy intranasal.....	1	.....	Plastic, nose.....	5	.....
Capsulectomy.....	1	.....	Pterygium, excision.....	25	.....
Cataract needling.....	1	.....	Pterygium, transplantation.....	12	.....
Enucleation.....	8	.....	Removal of nasal polyp.....	1	.....
Evisceration.....	1	.....	Rhinoplasty.....	1	.....
Excision of chalazion.....	4	.....	Removal of nasal spur.....	1	.....
Expression.....	2	.....	Removal of foreign body from nose.....	1	.....
Expression for trachoma.....	4	.....	Sinusotomy, frontal.....	11	.....
Extraction of cataract.....	13	.....	Submucous resection of nasal septum.....	68	.....
Frontal sinus radical.....	2	.....	Sinusotomy, maxillary.....	1	.....
Incision of surgical abscess.....	1	.....	Tonsillectomy.....	254	.....
Iridectomy.....	4	.....	Turbinectomy.....	6	.....
Keratotomy.....	1	.....	Various minor operations.....	117	.....
Lachrymal duct dilated.....	1	.....	Total.....	723	.....
Mastoidectomy.....	17	.....	Refractions.....	2,067	.....
Naso-dachryocystostomy.....	1	.....	Outside cases treated.....	8,154	.....
Papilloma, vocal cords, removal of.....	3	.....			
Plastic on eyeball.....	2	.....			

TABLE XVII.—CONSOLIDATED WARD LABORATORY REPORT ANCON AND COLON HOSPITALS.

Blood examinations.....	9,265	Urine examinations.....	22,324
Estivoautumnal.....	1,381	Albumen.....	6,314
Tertian.....	213	Casts.....	3,663
Mixed tertian and estivoautumnal.....	51	Sugar.....	731
Quartan.....	9	Pus and blood.....	6,831
Differential blood counts.....	527	Indican.....	763
Leucocyte counts.....	1,245	Epithelia.....	7,486
Red blood counts.....	68	Bile.....	217
White blood counts.....	53	Trichomonas vaginalis.....	2
Hemoglobin estimations.....	1,002	Hemin crystals.....	8
Secondary anemia.....	6	Guaiac tests.....	213
Lymphacytosis.....	4	Ciliated monads.....	24
Poikilocytosis.....	5	Triple phosphates.....	63
Anisocytosis.....	5	Amorphous phosphates.....	4
Filariasis.....	2	Red blood cells.....	13
Spirilla of relapsing fever.....	3	Urea determinations.....	16
Stool examinations.....	6,910	Acetone tests.....	95
Ascaris lumbricoides.....	101	Calcium oxalates.....	6
Uncinaria ova.....	414	Uric acid crystals.....	2
Tricocephalus dispar.....	339	Benzidine tests.....	22
Strongyloides intestinalis.....	211	Sputum examinations.....	3,018
Amoeba.....	44	Tubercle bacilli.....	343
Ciliated monads.....	185	Pus cells.....	9
Bilharzia.....	9	Pneumococci.....	10
Pus and blood.....	918	Smear examinations.....	568
Entameba, histolytica and tetragena.....	41	Examination of spinal fluid.....	56
Guaiac tests.....	182	Examinations of vaginal and urethral discharges.....	274
Cercomonas intestinalis.....	16	Examinations of the eye.....	42
Tenia saginata dispar (ova).....	6	Examinations of various smears and discharges.....	29
Blood and mucus.....	3		
Benzidine tests.....	23		

TABLE XVIII.—ANCON HOSPITAL.

## NATIONALITY OF PATIENTS.

Class.	Number treated.	Americans.		Other nations.	
		White.	Colored.	White.	Colored.
HOSPITAL PROPER.					
Panama Canal employees.....	3,474	705	7	274	2,488
Panama Railroad employees.....	1,164	89	.....	43	1,032
Panama pay patients.....	12	.....	.....	1	11
Other pay patients.....	4,727	2,682	2	741	1,302
Charity patients.....	671	161	.....	58	452
Total.....	10,048	3,637	9	1,117	5,285
INSANE DEPARTMENT.					
Panama Canal employees.....	22	1	.....	6	15
Panama Railroad employees.....	10	1	.....	.....	9
Panama pay patients.....	289	2	.....	31	256
Other pay patients.....	46	23	.....	8	15
Charity patients.....	74	5	.....	5	64
Total.....	441	32	.....	50	359
Grand total.....	10,489	3,669	9	1,167	5,644

Number of days' relief furnished patients..... 273,173  
 Cost of subsistence per patient per day..... \$0.226

TABLE XIX.—COLON HOSPITAL.

## NATIONALITY OF PATIENTS.

Class.	Number treated.	Americans.		Other nations.	
		White.	Colored.	White.	Colored.
Panama Canal employees.....	641	189	.....	92	360
Panama Railroad employees.....	540	70	.....	30	440
Panama pay patients.....	219	7	.....	23	189
Other pay patients.....	535	213	.....	161	161
Charity patients.....	103	25	.....	11	67
Total.....	2,038	504	.....	317	1,217

Number of days' relief furnished patients..... 13,872  
 Cost of subsistence per patient per day..... \$0.324

NOTE.—For report of surgical operations at Ancon and Colon Hospitals see Table XV. For consolidated ward laboratory report see Table XVII.

TABLE XX.—PALO SECO LEPROSY ASYLUM.

## NATIONALITY OF PATIENTS.

Class.	Number treated.	Americans.		Other nations.	
		White.	Colored.	White.	Colored.
Panama pay patients.....	43	.....	.....	3	40
Charity patients.....	23	.....	.....	2	21
Panama Canal employees.....	3	.....	.....	.....	3
Total.....	69	.....	.....	5	64

Number of days' relief furnished patients..... 21,095  
 Cost of subsistence per patient per day..... \$0.240

TABLE XXI.—SANTO TOMAS HOSPITAL.

Class.	Remain- ing July 1.	Ad- mitted.	Died.	Dis- charged.	Remain- ing June 30.
Pay patients.....	30	1,022	29	1,009	14
Charity patients.....	404	9,766	965	8,776	429
Total.....	434	10,788	994	9,785	443

Average number of days' treatment per patient.....	15.34
Average number of patients constantly sick.....	451.92
Number of days' relief furnished patients.....	165,402
Cost of subsistence per patient per day.....	\$0.366

## NATIONALITY OF PATIENTS.

Class.	Number treated.	Americans.		Other nations.	
		White.	Colored.	White.	Colored.
Pay cases.....	1,052	34	4	488	526
Charity cases.....	10,170	119	9	1,501	8,541
Total.....	11,222	153	13	1,989	9,067

## PATIENTS TREATED AT DISPENSARY.

	White.	Colored.	Total.
Natives.....	602	7,111	7,713
Foreigners.....	863	6,709	7,572
Total.....	1,465	13,820	15,285

## SURGICAL OPERATIONS.

	Number.	Died.
Major.....	1,237	65
Minor.....	666	2
Total.....	1,903	67

TABLE XXII.—BOARD OF HEALTH LABORATORY.

## Bacteriological examinations:

Water.....	3
Milk.....	394
Fluids and exudates.....	181
Blood cultures.....	221
Throat cultures (diphtheria suspects).....	666
Cultures from autopsies.....	20
Stool cultures.....	246
Urine cultures.....	336
Sputum.....	64
Oysters.....	1
Widals.....	2
Pus.....	3
Rats.....	11,471
Cultures, miscellaneous.....	7
Examinations:	
Leper suspects.....	23
Blood for malaria.....	296
Blood counts differential.....	78
Gonococcus stains.....	3
Pyorrhea cases.....	3
Stools for parasites.....	17
Blood for trypanosomes.....	27

## Chemical examinations:

Carbolic acid.....	5
Alcoholic beverages.....	22
Stomach contents.....	3
Urine.....	115
Various liquids, fluids, etc.....	30
Various metals.....	2
Milk.....	251
Gasoline.....	9
Kerosene.....	6
Opium.....	3
Sodium fluoride.....	1
Electrolytes for storage batteries.....	23
Disinfectants.....	1
Miscellaneous.....	19
Renal calculus.....	2
Glutlon flour.....	3
Miscellaneous:	
Agglutination reactions.....	49
Autopsies.....	357
Bodies embalmed.....	44
Pathological tissues prepared, frozen.....	25
Pathological tissues prepared, paraffin.....	4,324

TABLE XXII.—Board of Health Laboratory—Continued.

Miscellaneous—Continued.						Miscellaneous—Continued.					
Surgical pathological tissues and neoplasms reported.....	354					Blood for fat.....					1
Dark field examinations.....	46					Cremations.....					102
Vaccine inoculations, antityphoid.....	28					Water.....					4
Vaccine treatment, autogenous, prepared.....	21					Tallow.....					1
Wassermann reactions.....	6,518					Roast mutton.....					1
Animal inoculations.....	37					Butyric-acid tests on spinal fluid.....					7
Preparations of salvarsanized serum for intraspinal treatment.....	11					Fat determinations of milk.....					18
Vaccine points manufactured.....	15,310					Butyric acid.....					13
Interments.....	302					Paint.....					1
Animals autopsied.....	111					Heroin.....					1
Milk sediments.....	175					Chloride of lime.....					1
Ice cream.....	10					White brass.....					5
Alcohol.....	1					Examination of spots on clothing.....					1
						Specific gravity determination of stovain solution.....					1

Stations.	Anopheles-albimanus.	Anopheles-farsimaculata.	Anopheles-argyritarsis.	Anopheles-malefactor.	Anopheles-apicimacula.	Anopheles-pseudopunctipennis.	Culex and allied genera.	Mansonella titillans.	Stegomyia (Aedes colopus).	Wyeomyia.	Delinocerites.	Aedes taeniorhynchus.	Anopheles-eiseni.	Lesticoecania.	Aedeomyia squamipennis.	Damaged Anopheles.	Total.
Ancon.....	59		1				2,907	29	201			1				2	3,200
Bahoa.....	123			3	2		2,492	682	15			31	1			1	3,350
Corozal.....	329		1	2	1		344	601	4	2		27				1	1,315
Pedro Miguel.....	380		1	6	7		1,139	3,079	6	7		19				1	4,645
Paraiso.....	150			3	1	2	3,393	235	253			2				1	4,040
Red Tank.....	21						21					3				3	291
Lirio and Cerio.....	60			3			3,076	3,067	76			1					6,283
Rio Grande.....	171	1		1	9		1,305	4,568	90							1	6,146
Dredges, Culebra Cut.....	58						18,230	660	957			1					19,906
Tower K.....	192						3,447	1,272									4,711
Gamboa.....	870		1				7,150	5,015	5							5	13,046
Other places in Pedro Miguel District.....	94		1	1		2	802	268	27							1	1,196
Gatun.....	8,444	198	1	35	6	2	3,070	230	126	351		23				1,906	14,392
Frijoles.....	22,394	60		9	1		18,045	6,141	15	15						4,587	51,267
Monte Lirio.....	14,348	10					2,696	1,877		10						3,619	22,560
Darien.....	701			2			4,138									5	4,846
Other places in Gatun District.....	168						4									4	176
Barracks, Cristobal.....	1,797	255		9	4		8,886	14	7			10				5	10,987
Mount Hope Village.....	2,048	168		5	2		7,806	32	41			1				44	10,147
Colon.....	259	28					1,453	21				25				4	1,795
Silver, married quarters and cars.....	448	22		1			3,182		6							8	3,667
Other places in Colon, Cristobal District.....	290	5	3				2,227	2	12							31	2,570
Camp Gaillard.....	35			8	1	5	5,509	7,630	9	79		21		7			13,304
Empire.....	1						2,235	1,169		1		2					3,408
Camp Otis.....	8						121	3,607				5					3,741
Fort Randolph.....	2,378	230					874	144		36		286				22	3,970
Fort Sherman.....	681	31		4			272	264				103					1,355
Total.....	56,507	1,008	9	92	18	28	104,829	40,850	1,850	465	36	561	1	7	2	10,251	216,514

NOTE.—The table of mosquitoes identified does not attempt to give comparable data for different stations, since the period covered is not equal for all places. For instance, collections were not begun at Fort Randolph and Fort Sherman until June, 1916.

TABLE XXIII.—ISSUES OF QUININE.

Month.	Kilo-grams.	Pounds avoirdupois.
July.....	39.40	86.86
August.....	43.20	95.24
September.....	23.00	50.71
October.....	34.33	75.68
November.....	42.33	93.32
December.....	6.16	13.59
January.....	7.15	15.73
February.....	20.15	44.42
March.....	4.25	9.37
April.....	18.50	40.79
May.....	21.00	46.29
June.....	11.00	24.25
Total.....	270.47	596.25
Average per month.....	22.54	49.69

TABLE XXIV.—SANITATION.

CITY OF PANAMA.	
Mosquito, rat, and fly work:	
Miles of ditches cleaned.....	88.2
Miles of ditches dug.....	10.9
Square yards of pools oiled.....	5,079,487
Water containers treated.....	150,639
Mosquito breeding places found.....	3,425
Fly breeding places found.....	1,522
Quarts of flies trapped (13,000 per quart).....	400
Rats trapped.....	9,352
Square feet of vegetation removed.....	611,620
Disinfection work: Rooms disinfected.....	116
Material used:	
Crude oil (gallons).....	49,567
Larvacide.....	7,559
Inspection of houses and yards:	
Houses and yards inspected.....	64,343
Notices served and nuisances abated.....	4,069
Number of old buildings condemned.....	128
Number of buildings demolished.....	52
Number of yards cleaned.....	82
New buildings:	
Number of plans for new buildings approved.....	228
Number of permits granted for repairs to old buildings.....	1,004
Garbage collection:	
Number of loads of garbage removed to dump and burned.....	57,497
Total number of cans of garbage emptied.....	901,180
Street cleaning:	
Number of square yards of streets cleaned daily.....	600,000
Number of square yards of streets sprinkled daily.....	82,500
Vaccinations: Number of persons vaccinated.....	2,631
COLON, CRISTOBAL, AND MOUNT HOPE.	
Water and sewers:	
Number of connections made during the year.....	143
Total number of connections made to date.....	8,931
Number of outstanding permits.....	967
Number of houses in which extensions were made.....	64
Houses:	
Plans approved.....	182
Permits to repair issued.....	717
Permits to occupy issued.....	176
Number of bills collected for work for private parties.....	1,792
Sanitation of Colon:	
Number of loads of yard garbage removed.....	7,438
Average number of cans of garbage removed daily.....	2,171
Number of acres of vegetation removed.....	663.5
Number of acres of streets cleaned.....	10,014
Number of private properties cleaned.....	6,980
Number of square yards of pools oiled.....	614,010
Number of mosquito breeding places destroyed.....	768
Number of water receptacles treated.....	613,777
Number of linear feet of ditches constructed.....	480
Number of miles of ditches maintained.....	10.3
Number of mosquitoes caught.....	7,637
Number of nuisances abated.....	3,064
Number of buildings inspected.....	91,649
Number of rats killed.....	2,930
Number of acres of alleys cleaned.....	1,260
Number of acres of streets sprinkled.....	569
Number of fly breeding places destroyed.....	542
Number of gallons of larvacide used.....	4,868
Number of gallons of crude oil used.....	11,977
Number of doses of quinine issued.....	57,853
Number of dogs killed.....	249
Number of cubic yards fumigated.....	62,110

Sanitation of Colon—Continued.	
Number of square yards of streets oiled.....	82,263
Number of gallons of oil used for streets.....	6,250
Sanitation of Cristobal:	
Number of square yards of pools oiled.....	87,500
Number of water receptacles treated.....	76,140
Number of mosquito breeding places destroyed.....	93
Number of fly breeding places destroyed.....	76
Number of buildings inspected.....	9,110
Number of gallons of larvacide issued.....	422
Number of gallons of crude oil used.....	2,471
Number of loads of yard garbage removed.....	2,096
Number of cans of garbage removed.....	165,506
Number of acres of vegetation removed.....	44.75
Number of nuisances abated.....	271
Sanitation of Mount Hope:	
Number of square yards of pools oiled.....	1,419,950
Number of water receptacles treated.....	169,200
Number of miles of ditches maintained.....	73.7
Number of mosquito breeding places destroyed.....	1,183
Number of miles of ditches constructed.....	6.6
Number of mosquitoes killed in outfit cars and quarters.....	25,056
Number of mosquitoes killed in barracks.....	25,093
Number of gallons of crude oil used.....	30,224
Number of gallons of larvacide used.....	3,455
Number of cans garbage removed.....	19,876
Number of acres of vegetation removed.....	480
Number of private properties cleaned.....	1
Number of fly breeding places destroyed.....	1
Number of mosquitoes caught on boats.....	155

## CANAL ZONE.

Work requests on supply department:	
Grass cutting.....	187
Screen repairing.....	90
Miscellaneous.....	98
Work requests on engineering department.....	179
Work requests on other departments.....	29
Notices served for abatement of nuisances.....	128
Arrests for violation of sanitary regulations.....	12
Convictions.....	9
Building permits approved.....	7
Inspections of closets.....	12,334
Inspections of stores.....	505
Inspections of restaurants.....	1
Inspections of shops.....	1,029
Garbage cans emptied daily.....	2,946
Closets disinfected.....	17,457
Houses fumigated.....	1
Rat traps used daily.....	499
Water and sewer connections made.....	4
Number of adult Anopheles destroyed at houses.....	81,905
Number of adult Culices destroyed at houses.....	150,338
Number of adult Stegomyia destroyed in houses.....	1,095
Number of containers found with Stegomyia larvae.....	42
Rats destroyed.....	4,948
Material used:	
Larvacide (gallons).....	8,873
Crude oil (gallons).....	141,181
Kerosene (gallons).....	6,955

## TABLE XXV.—QUARANTINE SERVICE.

## PORTS OF PANAMA-BALBOA AND COLON-CRISTOBAL.

Number of vessels inspected and passed.....	1,873
Number of vessels detained in quarantine.....	158
Supplementary inspections of vessels detained.....	650
Number of vessels fumigated on arrival.....	126
Number of vessels fumigated prior to departure.....	29
Number of crew inspected.....	125,906
Number of passengers inspected.....	46,682
Total number of persons inspected.....	172,588
Number of supplementary inspections.....	19,012
Number of persons vaccinated at ports of arrival because of compulsory vaccination law.....	5,589
Number of persons vaccinated at port of departure or en route because of compulsory vaccination law.....	9,910
Total number of persons vaccinated.....	15,499
Number of persons held in quarantine at the detention stations to complete period of incubation of yellow fever and plague.....	4,204
Number of persons held in quarantine on board vessels to complete period of incubation of yellow fever and plague.....	19,881
Total number of persons held in quarantine.....	24,085
Number of persons landed from foreign ports:	
Cabin.....	21,040
Steerage.....	13,387
	34,427
Number of persons embarked for foreign ports:	
Cabin.....	21,388
Steerage.....	14,655
	36,043

## Apparent decrease for the year from foreign ports:

Cabin.....	348	
Steerage.....	1,268	
Number of persons arriving from coast towns on small craft.....		1,616
Number of persons embarked for coast towns on small craft.....		23,089
Apparent increase for the year from coast towns.....		19,097
Total number of persons landed.....		3,992
Total number of persons embarked.....		57,516
Excess over number embarked.....		55,140
Less number for Pacific ports.....		2,376
Apparent decrease for year.....		2,872
Number of immigrants recommended for rejection.....		496
Number of bills of health viséed.....		276
Number of inspections of docks.....		1,590
Number of inspections of vessels at docks.....		709
		1,399

## BOCAS DEL TORO.

Number of vessels inspected and passed.....	207
Number of crew inspected and passed.....	15,095
Number of passengers inspected and passed.....	2,391
Number of passengers in transit inspected and passed.....	2,231
Number of persons held to complete incubation of yellow fever.....	4

TABLE XXVI.—PERSONNEL REPORT.

[Average number of employees at work during year.]

	1915-16	1914-15	June 30, 1916.		
	Total.	Total.	Gold.	Silver.	Total.
Chief health office.....	4	5	4	4	4
Medical storehouse.....	8	8	4	4	8
Quarantine service.....	43	42	11	34	45
Health office, Panama.....	164	140	11	144	155
Health office, Colon-Mount Hope.....	175	134	9	172	181
Ancon Hospital.....	348	345	119	240	359
Colon Hospital.....	38	34	15	25	40
Santo Tomas Hospital.....	6	5	6	6	6
Palo Seco Leper Asylum.....	26	23	2	17	19
Zone sanitation.....	127	109	7	132	139
Hospital farm.....	54	49	2	57	59
Dispensaries:					
Balboa.....	6	6	5	2	7
Corozal.....	2	4			
Cristobal.....		1			
Culebra.....		3			
Empire.....		2			
Gamboa.....	1	1	1		1
Naos Island.....		1			
Gatun.....	4	4	2	2	4
Margarita Point.....		1			
Paraiso.....	4	4	2	2	4
Pedro Miguel.....	3	3	2	1	3
Total.....	1,013	924	202	832	1,034

TABLE XXVII.—HOSPITAL AND TOTAL CASES OF MALARIA AMONG EMPLOYEES.

	Admissions.				Died.				Total cases.		Annual average per 1,000 deaths.		Annual average per 1,000 cases.		Number of employees.
	White.		Colored.		White.		Colored.								
	Hospital.	Total.	Hospital.	Total.	Hospital.	Total.	Hospital.	Total.	Hospital.	Total.	Hospital.	Total.			
July.....	70	105	193	199	1	1	1	1	263	304	0.67	0.67	88	101	35,981
August.....	48	71	138	146					186	217			59	72	36,024
September.....	25	45	107	110					132	155			45	53	34,827
October.....	25	37	57	58			2	2	82	95	.72	.72	29	34	33,419
November.....	15	20	43	43					58	63			20	22	34,224
December.....	18	26	46	47					64	73			23	26	33,551
January.....	10	19	30	30					40	49			15	19	31,223
February.....	15	18	26	27					41	45			16	18	30,497
March.....	8	11	7	9					15	20			5	7	33,084
April.....	6	9	12	13			1	1	18	22	.35	.35	6	8	33,856
May.....	7	8	20	22					27	30			9	10	34,393
June.....	20	24	38	38					58	62			22	24	31,501
Total.....	267	393	717	742	1	1	4	4	984	1,135	.15	.15	29	34	33,548

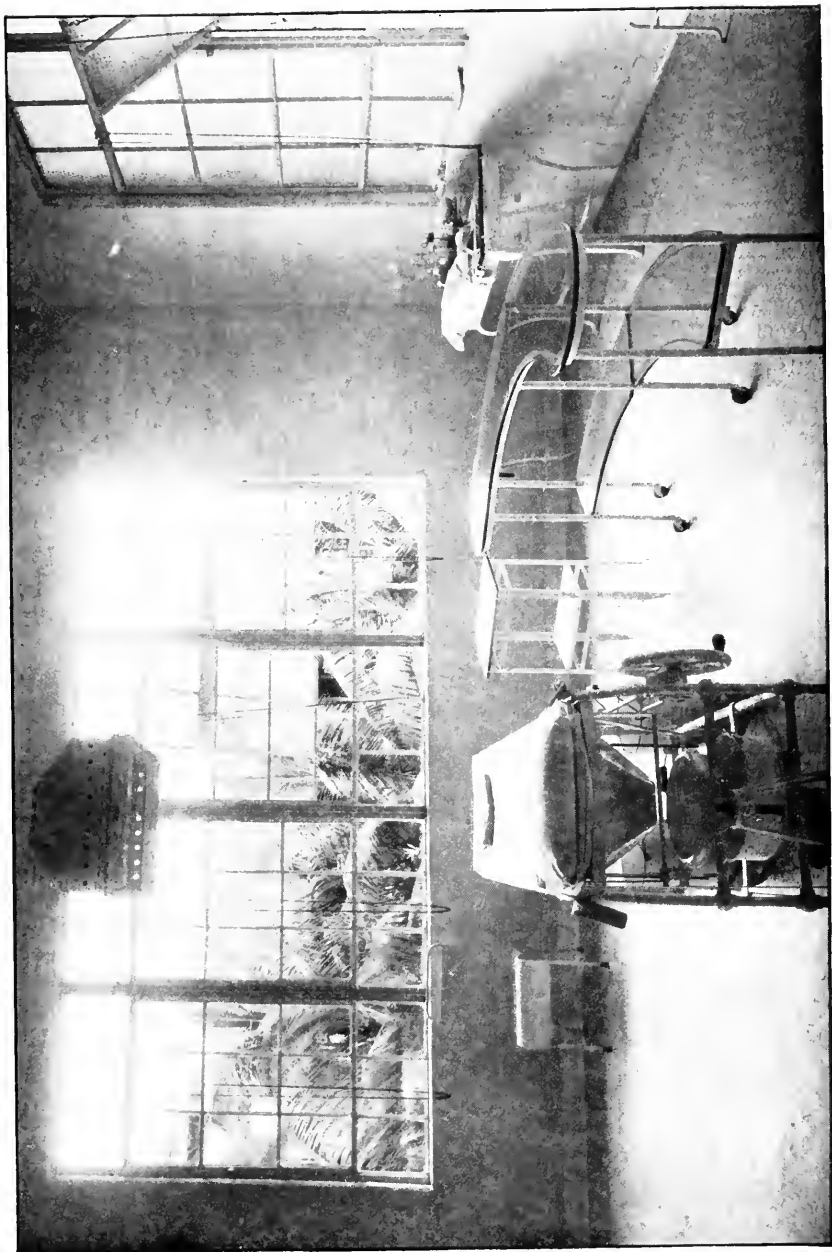




ANCON HOSPITAL. NEW WARD UNIT.



COLON HOSPITAL. ADMINISTRATION BUILDING, WITH ONE WARD UNIT.



COLON HOSPITAL. OPERATING ROOM.



## APPENDIX M.

### REPORT OF THE GENERAL PURCHASING OFFICER AND CHIEF OF THE WASHINGTON OFFICE.

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THE PANAMA CANAL,  
*Washington, D. C., July 14, 1916.*

SIR: I have the honor to submit the following report on the work of this office during the fiscal year ended June 30, 1916:

At the beginning of the fiscal year, Maj. F. C. Boggs, Corps of Engineers, United States Army, was on duty as general purchasing officer and chief of the Washington office of The Panama Canal, and continued as such until his relief by proper orders, on March 10, 1916, when he was succeeded by the undersigned, who was assigned to duty with The Panama Canal as assistant general purchasing officer and assistant chief of the Washington office on October 28, 1915, and continued on such duty until he relieved Maj. Boggs, on March 10, 1916. There has been no other important change in the organization during the year.

The following divisions are under my charge as general purchasing officer and chief of the Washington office: General office, including the appointment division and the correspondence and record division; office of the assistant auditor; and the purchasing department.

The recruiting of skilled mechanics in the United States has been materially handicapped during the past fiscal year, especially the latter half thereof, due to the activities at shipyards and other manufacturing establishments and the rising scale of wages paid at such plants. This is evidenced by the fact that about 48 per cent of those tendered employment failed to accept. During the year 1,176 persons within the United States were tendered employment for duty on the Isthmus in grades above that of laborer; 616 persons accepted and were appointed, covering 73 different positions. Three thousand five hundred and seventy-nine persons, including new appointees, those returning from leave of absence, members of employees' families and employees of contractors and their families, were provided with transportation from the United States to the Isthmus; and in response to inquiries and applications for employment during this period and in the issuance of appointments 14,210 letters were written, 2,760 telegrams sent, and 18,614 circulars mailed.

The work of the correspondence and record division, comprising all general administrative correspondence and miscellaneous matters, has continued about the same as heretofore.

The following statements show the volume of the transactions in the office of the assistant auditor, which includes the work of the disbursing clerk:

*Claim statement.*

On hand July 1, 1915.....	201
Received from July 1, 1915, to June 30, 1916.....	18, 371
<hr/>	
To be accounted for.....	18, 572
Passed for payment from July 1, 1915, to June 30, 1916.....	18, 108
<hr/>	
On hand June 30, 1916.....	464

There was an increase of 2,239 claims received and an increase of 1,445 examined and passed for payment over the preceding year.

*Financial statement of receipts and disbursements, July 1, 1915, to June 30, 1916.*

Disbursing clerk's balance July 1, 1915.....		\$490, 502. 60
Receipts:		
From United States Treasury.....	\$10, 519, 000. 00	
Miscellaneous collections.....	370, 165. 38	
	<hr/>	10, 889, 165. 38
To be accounted for.....		11, 379, 668. 02
Disbursements:		
Vouchered expenditures.....	10, 174, 594. 02	
Repayments to appropriations.....	188, 000. 00	
Refundments on collections.....	54, 170. 03	
Income tax paid to internal-revenue collector...	\$1. 08	
Collections deposited to appropriations and miscellaneous receipts.....	307, 936. 50	
	<hr/>	10, 724, 781. 63
		654, 886. 39
Disbursing clerk's balances June 30, 1916:		
General account as disbursing clerk.....	572, 674. 72	
Special-deposit account.....	82, 211. 67	
	<hr/>	654, 886. 39

During the fiscal year 15,182 vouchers for payment, amounting to \$10,174,594.02; 303 collection vouchers, amounting to \$370,078.05, and 1,379 settlements by transfer of appropriation, aggregating about \$417,000, were given an administrative examination, this being an increase over the preceding year of 1,710 disbursement vouchers examined and 273 transfer settlements made.

The work of the office of the assistant auditor includes the following: Forwarding each month to the Isthmus a statement giving classification of all expenditures in the United States covering salaries and incidental expenses, together with salaries and expenses in connection with the purchase, inspection, and testing of material; handling correspondence relative to claims for injuries to employees; keeping a record of all moneys collected, deposited, and reappropriated during the fiscal year; the examination of cash and net balances stated on the account current of the disbursing clerk and the forwarding of same to the auditor for the War Department for settlement; ascertaining and transmitting to the Isthmus monthly statements of the Treasury Department and disbursing clerk's balances; checking and reporting upon annual inventories of Panama Canal property in the United States; preparing for transmission to the Isthmus cablegrams giving advance notice of deposits made with the Treasurer and assistant treasurers of the United States for Panama Canal tolls, and handling of correspondence relative to the method of payment of tolls.

The assistant auditor's office also prepares all formal contracts issued in the Washington office, and during the year 132 contracts

were prepared, amounting to \$4,373,797.22. It also prepares all annual bonds and handles correspondence regarding the same.

Many cases, involving questions of law to be decided by the general purchasing officer and the chief of office, have been referred to the assistant auditor for examination and report. Reports for the defense of suits relating to Panama Canal contracts in the Court of Claims and in other courts are prepared by his office, as well as reports on all claims filed in the office of the Auditor for the War Department. The assistant auditor, as the legal officer in the United States of The Panama Canal, has, by direction of the chief of office, rendered assistance to the Department of Justice in connection with the preparation for trial, and at the trial, in the courts, of a number of very important cases in connection with contracts made by The Panama Canal. There are now pending in the United States courts four cases relating to Panama Canal contracts, including the case of the United States *v.* Pusey and Jones, under Washington Order No. 20378, the latter involving an aggregate amount of \$18,000. Three of these cases have been tried in the district courts. In one of these three cases an appeal has been taken by the claimant, and in the remaining two cases notice of appeal has been given by the claimant, but the appeal has not yet been perfected. Six suits are also pending in the United States Court of Claims, involving the sum of \$151,420.42.

Though reports have been made to the Department of Justice in certain cases mentioned above, the office of the assistant auditor is frequently called into consultation by attorneys representing the Government in the Court of Claims, and every possible assistance has been rendered.

The purchasing department has been continued as heretofore, organized under the supervision of the Chief of Engineers, United States Army, and in direct charge of an officer of the Corps of Engineers as general purchasing officer, with headquarters at Washington, D. C. The method of making purchases, including the inspection of materials purchased, has been carried on in the same manner as fully outlined in the last annual report.

While the principal purchases have been made from the Washington office, offices in charge of assistant purchasing agents have been continued at New York, New Orleans, and San Francisco, these latter offices having been also used for receiving and shipping such materials as are purchased for forwarding to the Isthmus through their respective ports. A small force of employees has also been maintained in the Medical Supply Depot, United States Army, New York, N. Y., in which office the purchases of all the medical and most of the hospital supplies have been made under the officer in charge of the depot.

A corps of inspectors, under the supervision of the inspecting engineer, located in Washington, has been maintained, and, as in the past, the work of inspection has been very much facilitated by assistance rendered by the field officers of the Corps of Engineers and by the Bureau of Standards, the Bureau of Mines, the Bureau of Chemistry, and the Medical Department, the Ordnance Department, the Signal Corps, and the Quartermaster Corps of the United States Army.

All independent inspection forces which were maintained during the past five or six years at points outside of Washington for inspection of special material, such as lock gates and electrical machinery, have finally been eliminated, with the exception of a small

force having charge of the inspection of the coal-handling plant, and it is expected that this force will close its work about October 1.

As explained in the last annual report, the number of orders issued, rather than the total value of purchases, is the criterion of the amount of clerical work in the Washington office, and while the number of orders issued in the fiscal year 1915 was greater than ever before, the number placed in the last fiscal year was still larger, as shown by the following comparative table:

*Summary of orders placed through the Washington office of The Panama Canal in the fiscal years 1915 and 1916.*

Month.	1914-15	1915-16
July.....	656	631
August.....	563	710
September.....	595	736
October.....	699	778
November.....	553	752
December.....	636	819
January.....	686	815
February.....	629	726
March.....	686	660
April.....	838	683
May.....	757	755
June.....	768	791
Total.....	8,096	8,856

A summary of all the orders placed through the Washington office by fiscal years from 1904 to 1915 was contained in the last annual report, as well as a summary of the amount of purchases for the same period.

The accomplishment of the increased work during the past fiscal year by practically the same force has been only possible through the continued high efficiency and devotion to duty of the personnel, many of whom often voluntarily work overtime in order to keep the work up to date.

The total value of orders placed by the Washington office in the last fiscal year was \$8,495,099.59, as compared with \$7,307,689.34 in 1914-15, bringing the grand total of purchases since 1904 up to \$118,159,235.45.

The principal items of equipment purchased during the past year are as follows: One refrigerating plant, \$47,850; 1 engine lathe, \$36,960; sectional steel doors and accessories for Piers Nos. 7 and 18, \$121,837.80; keel blocks and bilge blocks for dry dock at Balboa, \$50,390.70; 4 wooden dump scows, \$120,000; 2 steel dump scows, \$160,000; 2 oil-storage tanks, \$25,200; 1 50-ton locomotive jib crane for dry dock at Balboa, \$57,679.50; 11 capstans with motors, etc., for dry dock at Balboa, \$58,960; 1 tug (by transfer from the Engineer Corps of the Army), \$40,000; boilers for steamers *Ancon* and *Cristobal*, \$215,000. Shipments of cement were continued during the year under the contracts entered into January 7, 1909, and September 13, 1912, amounting to 528,465 barrels, making a total of 7,335,702 barrels delivered under these contracts.

EARL I. BROWN,

*Major, Corps of Engineers, United States Army,  
General Purchasing Officer, Chief of Office.*

Maj. Gen. GEO. W. GOETHALS, United States Army,  
*Governor, The Panama Canal, Balboa Heights, Canal Zone.*



## APPENDIX N.

### PRELIMINARY REPORT UPON THE POSSIBILITY OF CONTROLLING THE LAND SLIDES ADJACENT TO THE PANAMA CANAL.

[Made by the committee of the National Academy of Sciences appointed at the request of the President of the United States, dated, February 4, 1916. Received, March 16, 1916.]

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#### INTRODUCTION.

The committee of the National Academy of Sciences, appointed November 18, 1915, at the request of President Woodrow Wilson "to consider and report upon the possibility of controlling the slides which are seriously interfering with the use of The Panama Canal," submits this its preliminary report.

The committee as originally appointed consisted of 13 persons. For various reasons four (Messrs. A. L. Day, G. F. Becker, C. D. Walcott, and R. S. Woodward) were unable to visit the canal and participate in the deliberations of the committee. Those who took part in the preparation of this report are as follows:

C. R. Van Hise, H. L. Abbott, J. C. Branner, Whitman Cross, R. C. Carpenter, A. P. Davis, J. R. Freeman, J. F. Hayford, and H. F. Reid.

These members who will be spoken of as "the committee" in the report, sailed from New Orleans December 11, and arrived at Panama December 19. All spent two weeks in the Canal Zone, and three of them several days longer, working upon the problem submitted to them.

The part of the canal cut between Bas Obispo and Pedro Miguel will be called the Gaillard Cut in accordance with the official use of that term. The deepest part of the Gaillard Cut, at the continental divide, about 1 mile in length, will be called the Culebra District. The hill upon which the village of Culebra stands will be called Culebra Hill.

The general direction of the canal is nearly northwest and southeast, but nearer north and south than east and west. The various stretches vary considerably in this direction. For the sake of brevity in description, the canal will be regarded as running north and south, and directions at right angles to the canal will be called east and west and those parallel with it north and south.

The term "slides" when unqualified will be applied alike to material which is now in motion and to that which once has been in motion but is now quiescent. Where it is necessary to discriminate between these two conditions of the slides, one will be called "active" and the other "quiescent."

The Culebra District was visited by all members of the committee five days, and a number of the committee spent several additional days in this area. The attention of the committee was primarily directed

to the question of the control of the active East and West Culebra slides, but the extensive Cucaracha slide, now quiescent, was also examined with care. The committee also examined the massive hills of the Culebra District, and especially Gold, Culebra, Zion, and Contractors Hills, all of which are adjacent to the great slides.

The work of the committee in the field was facilitated in every way by Maj. Gen. George W. Goethals, Lieut. Col. Chester H. Harding, Lieut. Col. Jay J. Morrow, and Rear Admiral H. H. Rousseau; Gen. Goethals furnished records from his office, a brief history of the slides and their movements, and much other information which the committee desired; in short, all possible help has been given to the committee so that its members could carry on their work most effectively in their own way.

The committee has profited greatly by the geological studies of Mr. Donald F. MacDonald and by conferences with him in the field and in the office.

As the uninterrupted operation of The Panama Canal is a matter of great national importance, the committee plans a further study of the available data and expects in due time to make a fuller report; but it seems desirable to present promptly to President Wilson a preliminary report containing the views of the committee (so far as they can now be formulated), and such practical suggestions as the committee is able to offer.

#### THE THREE GREAT SLIDES.

The slides which led to the closing of the canal on September 18, 1915, were the great East Culebra and West Culebra slides. Gen. Goethals has described these slides in an article prepared for the press, under date November 15, 1915, and from this article the following statements are taken:

The East Culebra slide began on October 14, 1914, without any warning, and a section of the east bank north of Gold Hill settled vertically 20 feet. This section measured 2,000 feet (now extended to 2,700 feet) along the prism face and extended back 1,000 feet from the axis of the canal, generally along an irregular curved line. The top of the bank was from 300 to 350 feet above sea level, and the extension of the ground eastward was relatively flat country. In the settlement the upper portion which broke away remained practically parallel to its original position, and the benches which formed the upper part of the slide had not changed their relative positions, though they were badly broken up, while the lower strata were squeezed out across the canal. Subsequently the broken mass moved into the cut, reducing the depth of the water from 45 feet to 9 inches at one point. Until August, 1915, the dredges were able for the most part to keep up with the movement as it came down, and probably would have been able to maintain this condition had not a movement occurred on the west bank, necessitating work on this side to the detriment of the east side.

A crack was found on the slope of Zion Hill in June, 1914, but observations made upon it showed no movement and the solidity of the hill was never doubted. Subsequent to the break on the east side, a gradual but general breaking up of the west bank followed, and the crack on the slope increased in size and new ones developed farther up the hill, until finally one extended to the elevation of 480, the limit of the present break. The movement into the cut from the west bank occurred early in August, 1915, when a section of Zion Hill broke away and settled down. The edge of the break on this side is also a curve.

The movements from the two sides are toward the central portion of the inclosed area, and at this central portion is the obstruction to the channel. It first appeared as an island forced up from the bottom, then as a peninsula projecting from the east bank, and finally was pushed entirely across the channel completely closing it. \* \* \*

The length of the slides, which are directly opposite each other, is approximately 2,200 feet (the channel through which is navigable with the exception of 600 feet); the banks are 300 to 350 feet above sea level on the east and extend up to 480 feet above sea level on the west. The area of the territory affected on the east side covers 81 acres and on the west 78.5 acres.

Assuming that all material lying above planes extending from the outside limits of the bottom of the prism, reference 40, up to the limits of the breaks, will move into the cut, 7,000,000 cubic yards will have to be removed before the slides are entirely stopped. Mr. Comber, resident engineer of the dredging division, assumed a surface parallel to the surface existing on October 14, the date of the last complete survey, and 45 feet below it, on which basis 13,000,000 cubic yards would be the quantity to be handled. He thinks, however, that a mean between the two amounts may be more nearly correct, which was the method of arriving at the 10,000,000 cubic yard figure which has appeared in the press. It is at best only a guess. It must not be inferred from this that the canal will be closed until this amount is dredged, for such is not the case; on the contrary, it is the intention to pass ships as soon as the channel is secured through the remaining 600 feet, and there are reasonable grounds for assuming that a channel through the obstructed area can be maintained.

The active West Culebra slide extends 2,900 feet along the canal and 1,350 feet at right angles to it, measured from the axis of the canal to the farthest point of the slide.

Of the slides now quiescent, the most important is the Cucaracha. Gen. Goethals writes of it, in the article already mentioned:

On January 20, 1913, a break occurred at Cucaracha by which the rock bluff which was holding back the upper mass of clay broke at or below the bottom level of the canal, completely filling the prism with clay and rock, reaching to 69 feet above sea level on the opposite or west side of the cut. The length of the prism so filled was 1,600 feet. Steam shovels were scarcely able to keep pace with the movement, tracks were covered and disarranged, shovels overturned, and the difficulties of transportation increased, since only tail tracks sufficient for two or three cars could be maintained. Furthermore, the soft material increased the difficulties of the dumps. As the movement continued the clay broke farther and farther up the hillside.

The Cucaracha slide, as stated, extended 1,600 feet along the canal and 1,880 feet at right angles to it.

*Dominant importance of the three great slides.*—According to Mr. W. G. Comber, resident engineer in charge of dredging, the acreage of the three great slides is as follows:

West Culebra slide.....	60.8
East Culebra slide.....	70.5
Cucaracha slide.....	60.4
Total.....	201.7

In contrast with this, the total area of all other slides is 112 acres.

The dominance of the three great slides appears even more marked when the amounts of excavated and moving material are considered. Mr. Comber's figures for excavation accomplished to December 30, 1915, are:

	Cubic yards.
West Culebra slide.....	10,931,862
East Culebra slide.....	14,687,563
Cucaracha slide.....	9,901,602
Total.....	35,521,027

In contrast with this amount, the total excavations for the other slides to the same date have been 4,852,648 cubic yards.

If the amounts of material still to be removed are compared, the dominance of the three great slides is maintained. It is estimated that on December 30, 1915, there remained to be excavated:

	Cubic yards.
West Culebra slide.....	3,500,000
East Culebra slide.....	5,600,000
Cucaracha slide.....	500,000
Total.....	9,600,000

The total amount still to be removed from all other slides is estimated at the insignificant amount of 330,000 cubic yards. It thus appears that the amount of material already excavated and still to be removed from the three great slides is estimated at 45,121,027 cubic yards, whereas the corresponding amount for all the other slides is 5,182,648 cubic yards, or about one-ninth as much.

The foregoing facts are conclusive as to the dominant importance of East Culebra, West Culebra, and Cucaracha slides.

Since the three great slides are all in the Culebra District, this is the chief area of danger. This is the natural consequence of the fact that by far the deepest part of the canal cut is in this district, and that the weakest of the geological formations, the Cucaracha, is strongly developed here.

Slides may occur in other parts of the canal, but they will be relatively small and infrequent, for the banks are not high and the unstable ground has already slid down so that its surface has approached the angle of repose. Should slides occur, they are not likely to menace the operation of the canal. Slides great enough seriously to obstruct traffic in the canal could occur only in the Culebra District, which is but 1 mile long. The possibility of great slides in this section has therefore claimed the most careful consideration of the committee.

*General features of the Culebra District.*—In order that the views of the committee may be clearly conveyed, it is necessary briefly to mention and to illustrate by a map and photographs the more important features of the Culebra District.

The canal here traverses the highest land in its course. On the east side, rising abruptly from the canal, is Gold Hill. This is the highest hill near the canal; it reaches a height of 660 feet above sea level, or 620 feet above the bottom of the canal. It is composed mainly of hard intrusive basalt and hard tuff nearly surrounded by basalt. It separates the Cucaracha slide on the south from the East Culebra slide on the north. These slides have caused great breaks in the north and south flanks of Gold Hill, leaving nearly vertical cliffs, which are 275 feet high on the south flank. On the opposite western side of the canal there are three prominent hills, Culebra, Zion, and Contractors Hill, in order from south to north. Their elevations are:

	Above sea level.	Above bottom of canal.
Contractors Hill.....	415	375
Zion Hill.....	570	530
Culebra Hill.....	390	350

Zion Hill is of intrusive basalt, the other two mainly of hard tuff with some basalt. Contractors Hill nearly touches the waters of the canal opposite Cucaracha slide. Zion and Culebra Hills stand about 1,500 and 1,200 feet, respectively, from the canal, and in front of them lies the West Culebra slide. The slide has caused breaks in both of these hills. In the eastern front of Culebra Hill a road was carried down and a number of houses had to be removed; cracks roughly parallel to the canal have formed for a distance of about 100 feet beyond the prominent break, which seems to be the western limit of the slide at the present time, and extend to within 250 feet of the summit of the hill. Zion Hill also has suffered; a large mass has

fallen from its eastern face, leaving a vertical cliff, whose edge is only about 50 feet from the top of the hill. Contractors Hill has not been affected by the slides.

The great slides occur in the low ground adjacent to these hills, where a large amount of softer rocks had already been removed by natural erosion before the excavation of the canal was begun.

*Relations of the great slides to the hills.*—The Cucaracha slide is mainly confined to the area between Gold Hill and a subordinate basalt mass to the south. It extends from the canal for a considerable distance east of the crest of Gold Hill, and its head reaches the subordinate divide to the east. It is estimated that the Cucaracha slide drains an area of 80 acres. The slide is sharply limited on the north by the break in Gold Hill already mentioned, which extends approximately at right angles to the canal; its southern limit is not so well defined.

The limit of the East Culebra slide is sharply marked on the south by the break through the north part of Gold Hill which runs approximately at right angles to the canal. The northern boundary is not so sharply marked. The slide extends slightly beyond the subordinate divide on the east, so that east of the slide the drainage is away from the canal.

The West Culebra slide is limited on the south by breaks beginning at the canal some distance north of Contractors Hill, on the west by breaks which are sharply defined in Zion Hill, and less sharply in Culebra Hill. In the narrow valleys between Culebra and Zion Hills and between Zion and Contractors Hills the break extends beyond the divide, and the drainage is to the west.

*Possible extensions of the great slides.*—The very important question now arises, Will the great slides extend their limits and cause further serious trouble?

In general, the committee believes that no great extension of these slides is probable, because the soft rock constituting a very large part of the slides is quite limited in extent, except east of the East Culebra slide, and conditions elsewhere are unfavorable for extensions.

The Cucaracha slide can not greatly extend its area on account of the basaltic intrusions which surround it, but its eastern and southern limiting banks are still breaking down, and the movement of the slide may be revived to a small degree. Plugs or branches of intrusive basalt standing as obstructions across the former course of the slide restrain its movement, but the strength of these obstructions can not be determined from present exposures.

The West Culebra slide is pretty definitely limited on the west by the hard rocks of Culebra and Zion Hills, but between the active part of the slide and Contractors Hill there is a considerable mass of the Cucaracha formation, which seems never to have taken part in the slides. The effect on this mass of the settling of the adjacent moving material can not certainly be predicted. Indeed, it is not impossible that a considerable part of it may finally be set in motion, but the mass involved will be small in comparison with the active West Culebra slide.

East of east Culebra slide the soft formation continues, but the slope is gently away from the canal. Additions to the slide to the east are possible, but because of the slope and increased distance from the canal such possible additions would be in decreasing volume. Gold Hill limits the slide to the south.

## THE SOLIDITY OF THE HILLS OF CULEBRA DISTRICT.

In addition to the danger of the slides, is there danger that the canal may be blocked by the fall of the hills of Culebra District?

These hills are composed of intrusive bodies of basalt or of masses of the hard Obispo tuff commonly associated with basalt in this district. So far as can be judged from present exposures, they do not rest on the soft Cucaracha formation, but extend far into the earth and are self-supporting. Rock may slough off from them, but there is no evidence that they will collapse.

*Culebra and Zion Hills.*—The hard tuff of Culebra Hill practically limits the West Culebra slide in front of it. Cracks have formed in the tuff, and it is probable that some of the rock will break off as the slide settles. Zion Hill is a basaltic intrusion, and much rock has fallen from its face; more may follow. But the total amount that may fall will only make a relatively small addition to the upper part of the West Culebra slide.

*Gold and Contractors Hills.*—Gold and Contractors Hills rise steeply from the banks of the canal for 410 feet and 260 feet above the bottom of the canal, respectively, and then slope more gently to their summits. They are nearly, but not exactly, opposite each other. Gold Hill is chiefly composed of basalt, which formerly spread out near its top, and was partially supported on the softer Cucaracha formation. When the East Culebra and Cucaracha slides became active the support was removed, and a large mass of the basalt fell from the northern and southern sides of the hill. The lower part of Gold Hill on the side toward the canal is made up of hard Obispo tuff, bounded by a basalt dike, and there is little danger that it will yield.

Contractors Hill is of hard Obispo tuff, which is separated from the Cucaracha by a fault which dips into the hill at an angle of 60 or 70 degrees with the horizontal. There is a possibility that this part of the hill depends more for its support on the Cucaracha beds than seems probable, and as a measure of precaution all reasonable means should be taken to keep the Cucaracha beds in place, and especially the fault fissure should be kept closed to prevent water seeping in. If the borings, suggested later, to reveal the underground structure, show that these precautions are unnecessary, they can be discontinued.

The excavation of the canal and borings in its bottom show that a narrow belt between the two hills is composed of the soft Cucaracha beds; yet to the present time there has been no upheaval of the bottom of this part of the canal, nor any other sign to indicate that the hills have settled. It is believed, therefore, that the great masses of Gold and Contractors Hills are self-supporting and will remain so. There is no occasion to raze them.

## CAUSES OF THE SLIDES.

On account of their magnitude, the landslides have received serious consideration since the early days of the canal. But before measures for their control are taken up it is necessary briefly to discuss their causes.

The slides in the Canal Zone are essentially like many in other parts of the world; they are due to the inability of the earth or rock to support the weight of overlying material. Slow processes of natural erosion, rapid cutting by flooded streams and excavations by man frequently lead to landslides. Much of the canal is cut through weak rocks, and in the Culebra District the prism is exceptionally deep. It is clear that the conditions there are very favorable for slides.

The weakness of the rocks is due to several causes:

*Character of the rocks of the Culebra District.*—The rocks of Culebra District are of two kinds—stratified and massive. The chief material involved in the slides is the stratified Cucaracha formation. It is greenish gray in color, largely composed of clayey material with some layers of rather finely banded volcanic sandstone or tuff, only weakly consolidated. The Cucaracha beds are limited along the line of the canal to the Culebra District, but they have a thickness in places of over 400 feet. The soft slippery nature of its materials and their loose, unconsolidated condition make it unusually weak and unable to sustain any considerable load.

The Cucaracha beds alone are responsible for the great slides. The Obispo tuff is a rather coarsely fragmental rock, roughly stratified; masses of the tuff and of the massive columnar basalt have broken from the hills and added some material to the slides, but they have had no part in starting them.

*Structural weakness.*—The rocks, both stratified and massive, as shown by the work of Mr. MacDonald, are cut by numerous faults, and this is true of the rocks throughout the Gaillard Cut. Where there is a fault, the rocks have previously been broken, and therefore present a place of exceptional weakness. Some of the smaller slides outside the Culebra District are limited by faults.

An important source of weakness is the fracturing of the rocks by complex sets of joints. They occur in both stratified and massive rocks. The friable parts of the Cucaracha formation are broken by joints into fragments of various sizes down to a fraction of an inch. The massive rocks are fractured in every direction by joints on a much larger scale.

*Earthquakes.*—A consideration of the earthquakes felt in the Canal Zone and a careful examination of the instrumental records kept near the Pacific end of the canal since the end of 1908 dispel fear of serious damage to the canal or its accessories by earthquakes. A number of pretty sharp shocks have been felt in the Zone, but they have originated at a distance of about 120 miles from the Zone. A few fairly sharp shocks had their origin about 80 miles distant, and two or three, which were not felt and which made a very feeble record on the delicate seismographs, were much nearer. At the time of the very sharp shocks of October, 1913, a prism of earth 60 feet high and with a base of about 100 square feet broke off the steep slope near the top of the Cucaracha slide; this is quite insignificant. There is no evidence that any of the slides have been started or increased by earthquakes.

*The heavy rainfall.*—Investigations in many parts of the world have shown that excessive water in the ground is a great promoter of landslides. The strength of the Cucaracha clays is greatly decreased by the presence of water, and the heavy tropical rains keep them nearly

saturated the greater part of the year, for the broken and irregular surface of the slides and the open cracks around their borders greedily drink in the water that falls upon them.

In the Culebra District the average rainfall since 1884 has been 87.68 inches per annum, and during the time of the excavation of the canal it has been 84.75 inches per annum. Moreover, this rainfall is almost wholly concentrated in eight months of the year. The average for the rainy months during the period of excavation of the canal by the United States, from the middle of April to the middle of December, has been 80.01 inches. Where nearly 7 feet of water fall upon the surface of the country within eight months of the year, it is not surprising that there is difficulty in controlling the underground seepage. Indeed during these months the ground water table is practically at the surface, except possibly on the steeper slopes, and the movement of the underground water is so slow that even in the dry season the water table is not far from the surface in the level country. The New French Company found that the water table at the two points of the East Culebra slide was 6 and 16 feet below the surface, respectively. On the summit of Gold Hill the ground water falls 40 feet below the surface in the dry season, as indicated by the zone of weathering.

#### REMEDIAL MEASURES.

All slide material which reaches the canal must, of course, be removed at a certain expense and inconvenience. This work is being prosecuted by the engineers with great vigor. They estimate that about 9,000,000 cubic yards will have to be removed between the two Culebra slides, and the dredges can remove 1,000,000 cubic yards a month. But it must not be supposed that the canal will remain closed for nine months. As soon as the channel has been sufficiently deepened and the movement of the slides becomes so slow that the dredges, even when interrupted by the passage of ships, can more than keep pace with them, the canal may be opened for navigation. This time is probably not far off.

The committee believes that some sliding ground will continue to enter the canal for several years to come, though in diminishing amounts. Any relatively inexpensive measures which tend to arrest the present active slides or which promise to reduce the charge against maintenance of the canal in the future are fully warranted.

The composition of the rocks, their structural weakness, and earthquakes are beyond the control of man, but a partial control of ground and rain water and the relief of pressure by unloading certain areas are feasible, and the committee will confine its suggestions to these measures.

*Control of the water.*—As early as the time of the first French Company the advantage of controlling the water was recognized, and the New French Company made several attempts to keep the water out of the relatively small slides of their time by surface drains and tunnels, but with only partial success. The committee believes that every available and practicable device should be used to turn the water falling as rain from all ground that is sliding and prevent its entering adjacent ground, and it suggests the following measures:

1. Covering slopes with vegetation: Whether vegetation increases or decreases the amount of rainfall entering the ground is still a moot



question. The committee believes, however, that threatening ground bordering the slides, quiescent slides, and so far as practicable, active slides themselves, should be sufficiently covered with vegetation to prevent surface wash.

2. Closing peripheral cracks: Before extensive movements of the ground occur, warning is frequently given by the appearance of cracks peripheral to the coming slide. In some instances cracks exist for a long time before important movements take place. They are well illustrated upon Culebra Hill, west of the great break. As soon as they are formed they should be filled up, in order that they may not intercept surface water and lead it into the slide.

3. Drainage of undisturbed and threatened areas: Undisturbed and threatened areas near the slides should be thoroughly drained both by surface and by tile drainage, to keep as much water out of them as possible, for they may become unstable and they may supply water to the slides. The drainage water should be carried from the neighborhood of the slides as directly as practicable. Experiments with tile drainage on a small scale would soon show whether it is effective enough to justify its extension. The surfaces of the ground east of the East Culebra slide and in places west of the West Culebra slide slope away from the adjoining slides and the water can be readily removed. But a considerable area above the Cucaracha slide drains naturally into it. Some of the drainage can be diverted to the east, but the rest should, so far as possible, be collected by surface and tile drains and be carried to the canal through a large concrete-lined surface drain.

4. Drainage of the great slides: A complete system of open drains should be established on the great slides and the water carried away as directly as possible. The main drains should be made impervious on the Cucaracha and, so far as practicable, on the two Culebra slides.

5. Drainage by tunnels: Drainage by means of tunnels might be adapted to a few special cases, but should be tried with caution, and extended only in cases which promise results commensurate with the cost. The tunnels should be built underneath the sliding ground in the undisturbed material and strongly timbered so as to avoid risk of collapse, which would not only destroy the tunnel but would also disturb the overlying material. From the main tunnel smaller branches may be extended into the material to be drained and frequent borings made from the surface to conduct drainage water to the tunnels from the overlying strata. Such a system would be expensive, but might be effective in draining the area tapped by it.

*Relief of pressure.*—It is suggested that a cut be made by sluicing in the East Culebra slide, starting at an appropriate point on the canal and diverting from it diagonally in a general southeasterly direction, in the zone of gentle slopes and in such a position as to reach the large pond which now exists on the slide. This cut would partly separate the roughly rectangular slide into two approximately triangular parts, and the adjoining ground could be sluiced along it into the canal. It would provide a main drainage line for the ground on both sides of it, would empty the surface ponds and would lower the ground water in adjacent sliding material. The pressure of the triangle of ground in the rear of the cut against the triangle in front of it would be lessened; and it is probable that movement in the for-

ward part of the slide would cease sooner than it would otherwise. When the cut is once established it offers a second line of defense against the slide by making it possible to work along two fronts.

A somewhat similar cut should be made in the West Culebra slide. It should begin at the main drainage line opposite Culebra Hill and extend diagonally from the canal in a general southerly direction, and should drain the existing pond.

#### STUDIES FOR THE FUTURE.

In addition to the immediate remedial measures suggested above, there are certain observations and protective measures which should be undertaken with a view to the future.

*Detection of movements of earth or rock.*—A few slides are now in motion, but many more are quiescent. A slide is not necessarily "dead" because it has not moved notably for a few years. Its stability may hang on a delicate balance which may be disturbed by some slowly developing weakness. There is also a bare possibility that Gold and Contractors Hills are not so firmly supported as they are believed to be. Repeated surveys of properly placed signals for a number of years to come should be made in order:

(a) To indicate in good time where additional work of prevention is needed, to indicate how large a dredging fleet must be kept in readiness, and to furnish to the engineer of maintenance advance indications of emergency conditions.

(b) To test the effectiveness of remedial measures which may be taken to control or prevent slides. These tests would be more sensitive and definite than the mere occurrence or nonoccurrence of slides.

(c) To furnish a reliable basis for confidence when, in the course of time, it appears that the earth and rock movements have so decreased that a condition of stability may be inferred.

*Core borings.*—Definite information relative to the rock underlying Gold and Contractors Hills is wanting. Many years ago some borings were made at stations 500 feet apart along the center line of the canal, some of them to a depth of 40 feet below sea level.

Two or three core borings should be made on each side of the canal with a drill which would give large cores. At least one horizontal and one inclined hole should be bored on each side, their precise location to be fixed by a geologist.

*Underground water and related data.*—As underground water is of paramount importance in promoting slides, it should be carefully studied in the Canal Zone. A satisfactory investigation of this problem would require the following determination and studies:

1. Profiles of water table for different localities of the Culebra District:

- (a) In the wet and dry seasons;
- (b) In areas in which remedial measures have been applied and similar areas where they have not.

2. Percentage of porosity of the several formations of the Culebra District:

- (a) Absolute.
- (b) With regard to size of grain.

3. The effect of tropical vegetation with the accompanying humus, its removal and its restoration, on:
  - (a) The amount of water which sinks underground in sliding and in undisturbed areas.
  - (b) Chemical action, such as oxidation, hydration, carbonation, etc.
  - (c) The composition of the water.
  - (d) Changes in underground temperatures.
4. The nature of the changes which result in the disintegration and decomposition of the various rocks of the Culebra District when exposed to weathering agencies:
  - (a) With regard to volume.
  - (b) With regard to chemical changes, i. e., oxidation hydration, carbonation, action of acids, etc.
5. The chemical changes which cause the so-called hot areas described by Col. Gaillard and Mr. MacDonald:
  - (a) Direct, in production of acids, etc.
  - (b) Indirect, i. e., the effect of produced acids upon the materials, including water and rock.
6. Observations to determine whether similar changes to those in the hot areas take place elsewhere to a less extent over large areas, and whether such changes affect the slides.

*Mechanical testing of the rocks.*—Sliding is largely dependent upon the strength of the rocks; which in turn is affected by the water content. The strength of the massive igneous rocks is well known to be great, and need not be determined. But the Obispo, Cucaracha, and other formations of the Gaillard Cut should have their strength tested when saturated with water, when moist and when dry; and under rapid and slow deformation. If the tests show that much less force is required to deform the rocks when saturated or moist than when dry, this will emphasize the importance of keeping the water from these rocks so far as possible.

The tests should be made on fresh rocks and therefore in the Canal Zone. The specimens tested should be as large as is feasible for a testing machine of 200,000 pounds capacity.

*Earthquake studies.*—There are now two seismographs installed in the Administration Building at Balboa Heights. It would be an advantage if the smaller instrument should be removed to a second station, for instance Colon, in order that the origin of earthquakes, occurring in regions within two or three hundred miles of the Canal Zone, may be more definitely determined. Some of the stronger shocks felt in the Zone have thrown the needles of the delicate seismographs off the paper and left the records incomplete. A low-power instrument, magnifying about four times would secure a record of the movements of the ground in these cases.

#### GENERAL CONCLUSIONS.

It is obvious that the sliding material which enters the canal must be removed. The important thing for the future is to prevent ground from entering the canal. The chief remedy proposed by the committee to retard the movement of the slides now in motion and to prevent the slides from extending their areas, is to reduce the amount

of water which goes underground. Methods have been suggested by which this can be done; and they should be vigorously applied to all moving and threatening areas.

The committee looks to the future of the canal with confidence. It is not unmindful of the labor necessary to deal with the present slides; and it realizes that slides may be a considerable, but not an unreasonably large maintenance charge upon the canal for a number of years; it also realizes that trouble in the Culebra District may possibly again close the canal. Nevertheless, the committee firmly believes that, after the present difficulties have been overcome, navigation through the canal is not likely again to be seriously interrupted. There is absolutely no justification for the statement that traffic will be repeatedly interrupted during long periods for years to come. The canal will serve the great purpose for which it was constructed, and the realization of that purpose in the near future is assured.

## APPENDIX O.

### REPORT OF GEOLOGIST.

WASHINGTON, D. C., *September 8, 1916.*

SIR: I take pleasure in sending herewith my small contribution to your annual report for the fiscal year just past.

Appended to the report is a copy of a fairly complete table of the slides, compiled by Mr. Arthur Raggi under my general direction.

#### INTRODUCTION.

In the latter part of October, 1915, the writer, while making an unofficial trip to Central America, spent two days on the Canal Zone. During that visit he, in company with Gen. Goethals and Col. Harding, made a brief examination of the large slides that were then active on both sides of the canal and which had blocked the channel of Gaillard Cut near Culebra. After the examination, the writer, with the permission of Gen. Goethals, gave to a press representative, in order to combat the pessimistic ideas with regard to the slide conditions then current in many places, except on the Canal Zone, a statement in substance about as follows:

When the dredges shall have completed a narrow cut through the blocked part of the channel so that dredges and barges may have room to pass and to attack the slides at any point, the end of slide trouble will have begun. The small channel thus formed will almost surely continue to be made wider and deeper until in 8 or 9 months' time it will attain well toward the original width of the canal. It is possible that the channel may become closed again for a time within the next few months; but when the dredges once remove all of the material now moving, the channel will never again be closed by slides. Small slides will occur from time to time, perhaps for a period of some years. These, though they will be a charge against maintenance, will not obstruct traffic.

It was thought at the time the above was given out that the narrow channel spoken of could be cut through the slide obstruction by the last of November. Owing to unforeseen difficulties, however, the dredges were not able to get it open for a couple of weeks after this date. With this small exception, the predictions then made have been verified.

#### RETURN TO THE CANAL ZONE IN DECEMBER, 1915.

The writer had been in Washington a few days after returning from his unofficial trip to Central America, when a cable was received from Gen. Goethals asking that he accompany to the Canal Zone the committee from the National Academy of Sciences, which was then leaving Washington to investigate the slide conditions. In compliance with this request, leave was obtained from the Geological Survey and the writer set out for Panama at once, arriving there on December 20, 1915. The duties to be performed were entered into immediately, and consisted in assisting the "slide committee" in its studies wherever possible. The writer's former experience and special knowledge of the geologic conditions in Gaillard Cut, extending over a period of some years, Gen. Goethals

believed would help the committee in its work, especially as some of the geologic features had become obscured by slides and would be difficult to trace out by anyone not familiar with their original form. Instructions from Gen. Goethals were to render the committee all possible service, both in its field and in its office investigations, and these instructions were gladly carried out.

#### THROUGH THE MAILS MANY SLIDE CURES WERE RECOMMENDED.

The matter of the slides had been so widely discussed in newspapers and journals that it was a familiar subject to most people in the United States and to many people in foreign countries. One of the results of this was that advice of all kinds, on how to cure the slides, was offered to the canal authorities. Sheafs of letters arrived, and the remedies varied from those whose virtue depended upon the occult to those founded upon sound engineering principles. The writers of the latter type of letter, some of them eminent engineers, forgot, perhaps, that it is always wiser to be sure one has properly diagnosed the trouble in every detail, preferably on the ground, before offering a remedy. The cures offered by persons with more or less engineering ability were mainly of two kinds, (*a*) those which proposed to strengthen the sliding slopes by means of reinforced concrete, by cementing the ground, by freezing, or in some other way; (*b*) those which proposed to drain off all of the underground water and to prevent water from entering the weak rocks at the surface, by a covering of asphaltum or other waterproof substance. The suggestions under *a* may be dismissed with the statement that a slide of some millions of cubic yards, which gives flowage-like motion to the soft rocks to a depth well below the bottom of the canal, can not be held in place by reinforcing of any kind, except, perhaps, at a cost vastly greater than that of digging away the entire slide and the ground adjacent to it.

All plans for controlling these vast slides by holding them back with concrete and steel, or with any other reinforcing, are absolutely impracticable. With regard to the suggestions under *b*, those for the control of the ground water, the writer has always maintained that the removal of all the moisture from the sliding rocks would certainly stop the slides. However, he has also maintained that the soft rocks which slide are so fine grained that their moisture content can not be removed by drainage of any kind whatsoever that would be practicable. Of course the fractured surface zone of the slides should be drained where practicable. With many eminent men insisting that drainage be at least tried, it became necessary either to spend a great deal of money in putting in tunnels and wells to test the drainage idea, or to make some inexpensive tests that would give positive information on the drainage question. In conference with President Van Hise, chairman of the committee, it was agreed that experiments of the latter type could and should be carried out as soon as possible. A geologist with special knowledge and training in underground waters, Prof. W. J. Mead, of the University of Wisconsin, was therefore invited by Gen. Goethals to come to the Isthmus and to carry out, in cooperation with the writer, experiments on the water content of the rocks that were sliding, the possibility of draining them, etc.

## EXPERIMENTS TO DETERMINE THE WATER CONTENT OF THE SLIDING FORMATION AND THE POSSIBILITY OF DRAINING IT.

After Prof. Mead's arrival a dry room about 7 by 10 feet, where a temperature of 100° C. could be maintained, was secured. Air-tight cans for taking 8 to 15 pound samples of the rock and conserving its moisture content until the samples could be brought to the laboratory and weighed were made. Laboratory space for determining the specific gravity of the samples, both by weighing in air and in water and by the pycnometer method, was arranged for.

## RESULTS OF THE EXPERIMENTS.

When all was ready 21 average samples of the Cucaracha or sliding formation were taken from below the water level of the canal. These samples, completely saturated, contained 12.20 per cent of water by weight, or 27.8 per cent by volume. The 16 average samples taken from well above the level of ground water, where the rocks were much jointed and fractured, and therefore perfectly drained, contained 10.60 per cent of water by weight. As shown above, 12.2 per cent of water by weight fills all of the pore spaces of the rock; therefore 10.6 per cent by weight fills only 87 per cent of them, leaving 13 per cent of the total pore space as having been emptied by drainage and by drying. Now, 13 per cent of 27.8 per cent is 3.6 per cent of the total volume of the rock. This shows that natural drainage of the most perfect kind would not remove more than 13 per cent of the water by weight, equivalent to 3.6 per cent of the volume of the rock. However, most of the samples from the drained rock were taken very close to the surface, so that very likely they lost some of their water through drying out by the heat of the sun, for the dry season was more than a month old at the time they were collected.

These facts show that while the sliding rocks have a high percentage of pore space, the pores are mostly of capillary size and are filled with water which obeys the laws of capillarity, and which can not therefore be drained off. These experiments definitely established that all cures by drainage which had been offered to and urged on the canal authorities were absolutely futile, and the money which might have been wasted in worthless tunnels, wells, and acres of asphalt covering was saved for the only remedy that could bring permanent cure under the circumstances—dredging.

## MINOR REMEDIES.

While the heavy rains of the wet season can add little or nothing to the water content of the unfractured Cucaracha rocks—for the above experiments have shown that those rocks are always practically saturated—the heavy rains do add much water, and therefore weight and slipperiness, to the upper zone of the sliding ground which has been broken by innumerable cracks, fissures, and crevices. The writer has always advocated surface drainage as a minor remedy for ground that has been broken by slide movements.

One of the most useful auxiliaries in the combat against slides is, it seems to the writer, the hydraulic grading machine, several of which are in use on the canal. This machine consists in a powerful hydraulic pump which forces the water up through a line of piping and finally,

under heavy pressure, through a giant nozzle which is directed so that the powerful stream from it will cut large open drains down across the moving material to the canal. It is also very effectively used to sluice off steep overhanging brows at the head of sliding ground and to fill up, with hydraulically stowed material, any large fissures and cracks that may gap open near the upper boundary of the slides. This hydraulic sluicing method washes the loose *débris* from the head of the slide down into the canal and thus brings sorted fine-grained material down to suction dredges. The washed-down product also helps support the toe of the slide temporarily until a considerable weight has been removed from the head of the slide, thus relieving dangerous slide-promoting pressure.

Other minor remedies recommended by the slide committee and carried out by the engineers, in conference with the writer, were as follows: (a) Surface drainage of local areas by tile and by open drains; (b) wells, consisting of pipes, with the bottom lengths perforated, were driven into the moving ground and into adjacent areas at intervals and measurements taken in them with a view to establishing the relations between the surface level of the underground water and the surface of the sliding and the solid ground. Up to the time of leaving the Canal Zone, April 16, 1916, the data from these experiments were not complete enough to establish any conclusions.

#### FUTURE OF THE SLIDES.

The writer believes that the slide problem is now practically closed, though small slides will occur from time to time, perhaps, for some years. They will not endanger canal traffic and will be only a charge against maintenance. In former reports, especially in the 1912 report of the Isthmian Canal Commission (p. 209), the writer gave his reasons for believing that Gold Hill and Contractors Hill, although to the layman they appear threatening cliffs towering above the canal channel, would not slide. He is of the same opinion still. So far these hills have stood solidly except for a considerable amount of material that has been sheared off the north and the south sides of Gold Hill by the vast frictional drag of the Cucaracha and the east Culebra slides.

The writer gave it as his opinion in 1913—he did not give “assurance”—that the Cucaracha dikes would prevent further movement of the Cucaracha slide. However, owing to the fact that the dikes were weakened below their exposed portion by well-developed columnar jointing, they finally gave way under the vast pressure of some millions of cubic yards behind them and gave renewed activity to Cucaracha slide. This slide is now practically dead, however, and will never again be a menace to canal traffic.

There are some other smaller slides along the canal which may have slight renewed activity from time to time, but none of them will in any way threaten stoppage of traffic in the canal, and all of them will, as time goes on, be brought to a state of absolute rest.

There is no need for the writer to further discuss the causes of the slides in this report. He has done that in the 1912 and 1913 reports of the Isthmian Canal Commission, in Bulletin 86 of the Bureau of Mines, and in other papers. The principles long ago laid down in



the above publications as to the causes of the slides and the proper remedies to apply to them, he has never found any necessity to change in any way, for they have stood the test of time and have been concurred in by the scientific men who have given special attention to the slide problem.

Very respectfully

DONALD F. MACDONALD,  
*Geologist.*

Maj. Gen. GEO. W. GOETHELS, United States Army,  
*Governor, The Panama Canal, Balboa Heights, Canal Zone.*

Yardage of excavation in slides of Gaillard Cut.

Location.	Date when slide first developed.	Date when slide became quiescent.	1901	Cubic yards excavated to date.					Cubic yards remaining Jan. 1, 1916.	Cubic yards remaining July 1, 1916.	Area in acres.	Frontage west.	Length east.
				July 1, 1911.	July 1, 1912.	July 1, 1913.	July 1, 1914. <sup>2</sup>	July 1, 1915. <sup>3</sup>					
East Bas Obispo.....	September, 1910.	April, 1912.		111,000	117,000	117,000			117,000		(2.8	Feet.	600
East Haut Obispo.....	September, 1908.	June, 1913.		18,064	18,064	18,064			18,000		6		300
West Buenavista.....	November, 1908.	Active July, 1916.		43,301	162,000	162,000			262,238		5.1	800	
East Buenavista.....	May, 1912.	August, 1913.			48,000	48,000			48,000		1.2		1,130
East Las Cascadas.....	February, 1908.	March, 1912.		500,610	503,000	503,000			503,000		11.5		1,400
East Whitehouse.....	October, 1908.	October, 1911.		286,000	286,000	509,000			509,000		6.5		1,800
West Whitehouse.....	May, 1914.	May, 1914.							5,000			300	
West Whitehouse yard.	June, 1912.	June, 1913.				45,000			45,000			500	
East Powderhouse.....	October, 1901.	October, 1913.		145,000	413,000	543,000			614,260	545,000	1.0		2,600
East North La Pita.....	September, 1912.	August, 1913.				181,100			189,600		5.8		800
East Lower La Pita.....	May, 1910.			30,000	30,000	30,000			54,733		1.7		525
East Upper La Pita.....	December, 1909.			20,000	20,000	20,000			20,000		3.1		300
West Caniete.....	September, 1910.	March, 1912.		63,000	67,000	67,000			67,000		1.7		500
East Empire.....	May, 1912.	February, 1914.				933,700			1,071,272		9		4,250
West division office, Empire.	May, 1910.	May, 1913.		210,000		258,000			260,415		20.0		
West Lirio.....	April, 1912.	April, 1914.				221,200			333,068		2.6	1,000	
West New Culebra Village.	September, 1909.	Quiescent, 1914.									3.2	700	
East Hagan slide.....	February, 1913.	do.									19.64	2,250	
West Hodges Hill.....	August, 1912.	Quiescent, 1915.											1,200
West Culebra, Zion Hill.	October, 1907.	Active.		3,714,562	6,765,000	8,657,600			33,020,987	7,801,269	11.16	1,100	
East Culebra, Gold Hill.	January, 1907.	do.		2,329,784	4,290,000	5,966,200					60.8	2,900	
East Cucaracha.....	July, 1905.	do.		2,722,164	2,890,000	3,859,500			9,901,602	500,000	170.5		3,800
West Contractors Hill, north.	January, 1907.	Quiescent.		240,300					4,351,526		60.4		2,800
West Contractors Hill, south.	July, 1908.	June, 1911.		211,036	216,000	221,000			221,000			600	
East Cucaracha Village.	September, 1911.	December, 1912.			57,000	231,000			231,000		2.6		350
East Paraiso.....	March, 1907.	May, 1912.		322,620	385,000	385,000			385,000		4.0		1,100
East Pedro Miguel.....	January, 1913.	May, 1913.				3,300			3,300		5.7		600
Total.....						23,009,664	29,524,217	36,077,585	447,880,475			11,600	23,555

<sup>1</sup> Thirteen slides were in motion during fiscal year 1908-9, and from them 884,530 cubic yards of materials were removed and 983 cubic yards were estimated to be remaining in motion.

<sup>2</sup> From July 1, 1913, to July 1, 1914, 6,514,553 cubic yards were removed.

<sup>3</sup> By dredges.  
By hydraulic.

Total from slides July 1, 1914, to July 1, 1915.  
In addition to this quantity, dredges have removed from Cut 1,270,459 cubic yards, mostly due to small slides.

Cubic yards.  
6,361,450  
191,918  
6,553,368

\* Total approximate.

## APPENDIX P.

### TABLES SHOWING INCREASES IN SALARIES AUTHORIZED OVER ORGANIZATION OF JULY 1, 1914, AND INCREASES OF NUMBERS OF PERSONS EMPLOYED OVER NUMBER ALLOWED IN 1916 BOOK OF ESTIMATES, AS REQUIRED BY ACT OF CONGRESS APPROVED MARCH 3, 1915.

#### DEPARTMENT OF OPERATION AND MAINTENANCE.

Designation.	Increase in pay.		Increase in numbers.		Explanation.
	Rate authorized in organization July 1, 1914.	In-creased to—	Number authorized in 1916 Book of Estimates.	In-creased to—	
DREDGING DIVISION.					
Blacksmiths, \$1,680.....			1	2	1 in approved organization July 1, 1915; increase 1 account drill operations, east and west Culebra slides.
Draftsman, \$1,500.....			0	1	Temporary increase 1 account alterations dredge <i>Corozal</i> and three 15-yard dipper dredges.
Electricians, \$2,040 ..			0	2	Required for care and maintenance of electrical equipment on cranes <i>Ajax</i> and <i>Hercules</i> .
Engineers.....	\$1,863.00	\$2,040.00		4	increased in salary account placing tugs <i>De Lesseps</i> and <i>Sanidad</i> in regular tow-boat service.
Engineers.....	1,980.00	2,100.00		2	increased in salary account placing tugs <i>De Lesseps</i> and <i>Sanidad</i> in regular tow-boat service.
Engineers, \$2,100.....			14	17	15 in approved organization July 1, 1915; increase 2 account operation cranes <i>Ajax</i> and <i>Hercules</i> .
Engineers, \$1,860.....			26	37	35 in approved organization, July 1, 1915; temporary increase 2 account vacation relief officers pipe-line suction-dredge service.
Engineers (dipper dredge), \$2,640.....			2	4	3 in approved organization, July 1, 1915; temporary increase 1 account vacation relief chief engineers 15-yard dipper dredges.
Engineers (dipper dredge), \$2,100.....			3	14	12 in approved organization, July 1, 1915; temporary increase 2 to provide relief men account Sunday work, Gaillard Cut.
Engineers (steam), \$1,620.....			0	3	Account operation floating air-compressor plant for shore drill service, east and west Culebra slides.
Foremen (general), \$2,100.....			2	9	3 in approved organization, July 1, 1915; temporary increase 1 to provide relief account Sunday work, Gaillard Cut; increase 1 account placing Gamboa gravel plant on 12-hour working basis; temporary increase 1 to provide for vacation relief of drill foremen at Culebra slides; increase 1 to provide working force for hydraulic sluicing operations at Culebra slides; temporary increase 2 to provide sufficient supervision for shore drill work at Culebra slides.

Tables showing increases in salaries authorized over organization of July 1, 1914, and increases of numbers of persons employed over number allowed in 1916 Book of Estimates, as required by act of Congress approved Mar. 3, 1915—Continued.

## DEPARTMENT OF OPERATION AND MAINTENANCE—Continued.

Designation.	Increase in pay.		Increase in numbers.		Explanation.
	Rate authorized in organization July 1, 1914.	In-creased to—	Number authorized in 1916 Book of Estimates.	In-creased to—	
DREDGING DIVISION—Con.					
Levelman, \$1,200.....			0	1	Temporary increase 1 to provide for vacation relief of regular survey force.
Machinists, \$1,800.....			0	2	1 in approved organization, July 1, 1915 (called foreman machinist); increase 1 account placing Gamboa gravel plant on 12-hour working basis.
Machinists, \$1,680.....			1	6	4 in approved organization, July 1, 1915; increase 2 account operation cranes <i>Ajax</i> and <i>Hercules</i> .
Masters.....	\$2,040.00	\$2,220.00			2 increased in salary account placing tugs <i>De Lesseps</i> and <i>Sanidad</i> in regular tow-boat service.
Masters, \$2,640.....			7	9	8 in approved organization, July 1, 1915; increase 1 account placing floating cranes <i>Ajax</i> , <i>Hercules</i> , and <i>La Valley</i> under supervision of one licensed master.
Mates.....	1,860.00	2,100.00			4 increased in salary account placing tugs <i>De Lesseps</i> and <i>Sanidad</i> in regular tow-boat service.
Mates (craneman), \$2,280.....			0	15	11 in approved organization, July 1, 1915; temporary increase 4 to provide relief men account Sunday work, Gaillard Cut.
Mates, \$2,100.....			18	58	39 in approved organization, July 1, 1915; increase 12 account vacation relief for tow-boat officers, Gaillard Cut dredging service; increase 1 account consolidation of crews, floating crane boats; temporary increase 6 to provide positions for canal pilots and masters (marine division) over period canal closed to navigation.
Mates, \$1,740.....			6	12	10 in approved organization, July 1, 1915; temporary increase 2 to provide for vacation relief pipe-line suction-dredge service.
Nozzlemen, \$1,620.....			0	5	To provide working force for hydraulic sluicing operations at Culebra slides.
Operators (dipper dredge), \$2,580.....			4	14	12 in approved organization, July 1, 1915; increase 2 to provide vacation relief for operators, 15-yard dipper dredges.
Operators (crane), \$1,800.....			2	3	2 in approved organization, July 1, 1915 (called steam engineer); increase 1 account placing Gamboa gravel plant on 12-hour working basis.
Operators (pump), \$1,620.....			10	17	13 in approved organization July 1, 1915; increase 2 account relief relay pump operators, vacations and Sunday work; increase 2 to provide working force for pumps on hydraulic graders 2 and 3.
Rodmen, \$1,000.....			6	12	10 in approved organization, July 1, 1915; temporary increase 2 to provide for vacation relief of regular survey force.
Wiremen, \$1,617.20.....			2	3	1 in approved organization, July 1, 1915; increase 2 to provide relief men account vacations and Sunday work.
MARINE DIVISION.					
Clerks.....	2,100.00	2,400.00	1	2	Increased business made necessary larger clerical organizations in port captain's offices than was anticipated.
Clerks, \$1,800.....			3	4	
Master.....	2,197.80	2,220.00			Pay of one in each grade increased to conform to pay made for similar services by other divisions of canal.
Do.....	2,079.00	2,220.00			
Mates.....	1,860.00	2,100.00	4	6	Explanation in case of masters applies.

Tables showing increases in salaries authorized over organization of July 1, 1914, and increases of number of persons employed over number allowed in 1916 Book of Estimates, as required by act of Congress approved Mar. 3, 1915—Continued.

## DEPARTMENT OF OPERATION AND MAINTENANCE—Continued.

Designation.	Increase in pay.		Increase in numbers.		Explanation.
	Rate authorized in organization July 1, 1914.	In-creased to—	Number authorized in 1916 Book of Estimates.	In-creased to—	
MARINE DIVISION—Continued.					
Measurers.....	\$2,100.00	\$2,400.00	2	2	Increase in number due to increased traffic which required measurers to check each others work. Increase in pay due to inability to get competent men for salary estimated.
	2,400.00	2,400.00	6	2	Salaries paid necessary to retain services of properly qualified master mariners, especially in view of shortage of this class of men in merchant marine at home. Increase in numbers due to unforeseen increase in traffic.
	2,460.00	2,460.00	-----	1	
	2,520.00	2,520.00	-----	6	
Pilots.....	2,700.00	2,700.00	6	-----	
	2,880.00	2,880.00	-----	8	Explanation in case of masters applies.
	2,940.00	2,940.00	-----	1	
	3,000.00	3,000.00	6	8	
Marine engineers (later rated engineers, tug).	1,953.00	2,040.00	4	6	
Inspectors (motor boat).	-----	1,560.00	2	-----	Increased business necessitated great increase in number of small boats and competent inspector could not be obtained for salary estimated.
	-----	1,740.00	-----	2	
Recorder.....	2,100.00	2,400.00	-----	-----	Performs clerical work of marine superintendent in addition, this work having been performed in executive office.
Signal maintainer, \$1,650.	-----	-----	0	1	Aids to navigation being converted wherever practicable, from gas to electricity; largely increased mileage of electric wires supplying currents to aids made necessary employment of electric lineman or signal maintainer.
Operator of motor boats, silver roll position, \$60.	-----	-----	0	1	First employment made in accordance with approved policy of using American citizens (men with naval training when they can be obtained) on gold roll in place of aliens on silver roll in positions of boatswain, fireman, oiler, signal keeper, motor-boat operator, dock foreman, and seaman.
ELECTRICAL DIVISION.*					
Machinists, 50 cents	-----	-----	0	2	Temporary increase account of work dismantling Balboa air-compressor plant.
OFFICE ENGINEER.					
Draftsmen.....	(1)	2,400.00	0	4	Consolidation of drafting-room forces of department operation and maintenance, terminal construction division, building division, municipal engineering division, and electrical division, under the charge of the office engineer. The positions referred to are covered by the Book of Estimates under the appropriations for draftsmen under the estimates of the divisions referred, except in the case of the building division, which submitted no estimate for draftsmen.
	2,100.00	-----	2	22	
	1,800.00	-----	1	13	
	(1)	1,650.00	0	1	
	1,500.00	-----	1	2	
	(1)	900.00	0	2	

## SUPPLY DEPARTMENT.

Tinsmith, 44 cents per hour.	-----	-----	0	1	To perform work formerly assigned to silver employees, and which the Governor directed should be performed by gold employees.
Chauffeurs, \$125 per month.	-----	-----	0	8	To operate large automobile trucks, which Governor decided should be operated by gold employees.

Tables showing increases in salaries authorized over organization of July 1, 1914, and increases of numbers of persons employed over number allowed in 1916 Book of Estimates, as required by act of Congress approved Mar. 3, 1915—Continued.

## SUPPLY DEPARTMENT—Continued.

Designation.	Increase in pay.		Increase in numbers.		Explanation.
	Rate authorized in organization July 1, 1914.	Increased to—	Number authorized in 1916 Book of Estimates.	Increased to—	
Wheelwright, 56 cents per hour.	.....	.....	0	1	To perform work formerly assigned to silver employees, and which the Governor directed should be performed by gold employees.
Clerks, \$125 per month.	.....	.....	4	5	Transferred to supply department from the mechanical division, upon turning over to this department of operation of fuel-oil plants.
Gauger, \$150 per month.	.....	.....	0	1	
Foremen, \$175 per month.	.....	.....	0	2	
Pump operators, \$150 per month.	.....	.....	0	2	
Crib tenders, \$125 per month.	.....	.....	0	4	

## HEALTH DEPARTMENT.

ANCON HOSPITAL.					
Chief, medical clinic.	\$4,500.00	\$6,000.00	.....	.....	Account of revenue derived from consultations and services in connection with outside patients.
Physicians, \$3,000.	.....	.....	2	3	Five increases in salaries: (1) to retain \$250 per month for the physician acting as district physician, which was salary he was receiving at time estimates were made; due to increase in number of employees at Ancon and in Panama, the Ancon dispensary work has increased instead of decreasing, and the policy was adopted of allowing \$250 per month to district physicians at the larger dispensaries. (1) for the assistant to district physician, account of this man having none of the advantage in experience of the hospital proper. (1) for the obstetrician; necessary account unable to retain competent man at \$150. (2) for the two assistant physicians at Corozal Hospital for the Insane on account of the nature of the work and its many drawbacks, it is necessary to pay \$200 in order to retain the men and avoid a constant change of physicians at this place.
Physicians, \$2,400.	.....	.....	0	4	
Physicians, \$1,800.	.....	.....	9	6	
			11	13	Two increases in number: (1) account resignation of two internes necessary to retain one more physician than was estimated for. (1) for Corozal Hospital for the Insane; owing to unsettled conditions in the past, efforts at the insane asylum have been devoted mainly to the safekeeping of the inmates, with improvements in their physical condition and general physical welfare; with the great advance in psychiatry and treatment of the insane which has recently taken place, it was desired to give more individual attention to each patient, with a view to curing their mental complaints and thereby shorten their stay in hospital.

Tables showing increases in salaries authorized over organization of July 1, 1914, and increases of numbers of persons employed over number allowed in 1916 Book of Estimates, as required by act of Congress approved Mar. 3, 1915—Continued.

## HEALTH DEPARTMENT—Continued.

Designation.	Increase in pay.		Increase in numbers.		Explanation.
	Rate authorized in organization July 1, 1914.	In-creased to—	Number authorized in 1916 Book of Estimates.	In-creased to—	
ANCON HOSPITAL—Continued.					
Carpenter, \$1,791.36.....			0	1	These men had been regularly employed at Ancon Hospital, but a trial in the interest of economy was given of having the work done by the supply department; this was not satisfactory and the men were transferred back to the health department.
Plumber, \$1,866.....			0	1	
Assistant farm manager (Corozal farm), \$1,500.....			0	1	Necessary account increase in work of farm and to give proper supervision to dairy, it being impossible for the farm manager to give the dairy the amount of personal attention which conditions demand.
Chauffeur, \$900.....			0	1	For hospital ambulance, which requires a careful driver; and to make minor repairs to motor transportation of the hospital, which has replaced animal transportation.
Clerks, \$1,500.....			2	3	Increase in clerical work due to increase in number of pay patients; and to allow for sufficient relief for other clerks going on leave.
Nurses, female, \$1,020.....			0	3	3 nurses whose salaries were not decreased from \$1,020 to \$960—see explanation last year's report—were retained. Necessary to increase balance of 55 nurses to 65, account increase in number of private-room patients and to take care of leaves.
Nurses, female, \$960.....			53	65	
			53	68	
COLON HOSPITAL.					
Druggist, \$1,500.....			0	1	2 male nurses at \$1,260, estimated; a female nurse was substituted for one and the druggist for the other.
Nurses, female, \$960.....			5	6	
LINE HOSPITALS.					
Druggists, \$1,200.....			1	2	Increase for but 6 months; 8 male nurses at \$1,260 authorized and but 7 employed, the additional druggist filling the other positions.
Physicians.....	\$2,400.00	\$3,000.00			2 increased. 1 was for 1 month only, until Corozal dispensary could be closed; the other was for the district physician, Balboa, to retain him at the salary he had been receiving; on account of consolidation of work at the Pacific end, the work of this dispensary (as well as of Ancon) has grown instead of diminished.
ZONE SANITATION.					
Inspector, \$1,500.....			0	1	For but 3 months, while 1 inspector was absent on leave without pay.
HEALTH OFFICE, COLON.					
Clerk, \$900.....			0	1	Formerly 2 clerks in this office, and it was found impossible to get along with 1 and keep the work up to date, as the work of this office has increased, due to increase in population of Colon.
Inspectors, \$1,800.....			3	4	Necessary to continue the same number as previously employed, as the work at Colon has not decreased as estimated, and it was found that sufficient allowance has not been made for inspectors going on leave.

Tables showing increases in salaries authorized over organization of July 1, 1914, and increases of numbers of persons employed over number allowed in 1916 Book of Estimates, as required by act of Congress approved Mar. 3, 1915—Continued.

## HEALTH DEPARTMENT—Continued.

Designation.	Increase in pay.		Increase in numbers.		Explanation.
	Rate authorized in organization July 1, 1914,	In-creased to—	Number authorized in 1916 Book of Estimates.	In-creased to—	
QUARANTINE DIVISION.					
Veterinarian and meat inspector, \$2,400.	.....	.....	0	1	On account of the supply department instituting a beef-slaughtering establishment on the Isthmus.
Assistant veterinarian and meat inspector, \$1,800.	.....	.....	1	1	

## EXECUTIVE DEPARTMENT.

POLICE AND FIRE DIVISION.					
Policemen, first class	\$80.00	.....	75	139	23 additional officers employed in place of colored officers on July 1, 1915, at expense of Panama Railroad. On Apr. 20, 1916, 41 officers temporarily employed for military reasons, by direction of the Governor, but number was reduced to 16 at close of year. No other changes in salaries or number of men were made during the year.
DIVISION OF SCHOOLS.					
Teachers, high school, \$900.	.....	.....	4	5	Increased attendance in high schools. Offset by abolition of 2 silver teachers' positions at \$540 each.
Teachers, grade, \$810.	.....	.....	21	27	Number of pupils in grade schools greater than anticipated when estimates for 1916 were made.
Brake attendant.....	270.00	.....	0	1	Found impossible to abolish this position as anticipated when 1916 estimates were made.

## WASHINGTON OFFICE.

Temporary clerks for all offices.	\$2,000.00	\$3,328.78	.....	.....	Excess of \$1,328.78 due to increased work throughout the whole office. Approved by Governor Oct. 28, 1915.
Inspectors, \$1,500....	.....	.....	8	9	1 additional inspector required owing to temporary increase in the inspection work in the United States.



## APPENDIX Q.

### ACTS OF CONGRESS AFFECTING THE PANAMA CANAL AND EXECUTIVE ORDERS RELATING TO THE CANAL ZONE.

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## ACTS OF CONGRESS AFFECTING THE PANAMA CANAL AND EXECUTIVE ORDERS RELATING TO THE CANAL ZONE.

AN ACT Making appropriations to supply further urgent deficiencies in appropriations for the fiscal year ending June thirtieth, nineteen hundred and sixteen, and prior years, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the following sums are appropriated, out of any money in the Treasury not otherwise appropriated, to supply further urgent deficiencies in appropriations for the fiscal year ending June thirtieth, nineteen hundred and sixteen, and prior years, and for other purposes, namely:

\* \* \* \* \*

### DEPARTMENT OF STATE.

#### FOREIGN INTERCOURSE.

Exposition in the city of Panama: For additional amount for the suitable participation by the United States in an exposition to be held in the city of Panama, including the same objects specified under this head in the Diplomatic and Consular appropriation Act for the fiscal year nineteen hundred and sixteen, and also such compensation to the Commissioner of the United States appointed by the President as the Secretary of State shall determine, \$7,500.

Payment to Panama: To enable the Secretary of State to pay to the Government of Panama the fourth annual payment, due on February twenty-sixth, nineteen hundred and sixteen, from the Government of the United States to the Government of Panama under article fourteen of the treaty of November eighteen, nineteen hundred and three, \$250,000.

\* \* \* \* \*

Approved, February 28, 1916.

AN ACT Making appropriations for the legislative, executive, and judicial expenses of the Government for the fiscal year ending June thirtieth, nineteen hundred and seventeen, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the following sums are appropriated, out of any money in the Treasury not otherwise appropriated in full compensation for the service of the fiscal year ending June thirtieth, nineteen hundred and seventeen, namely:

\* \* \* \* \*

### NAVY DEPARTMENT.

\* \* \* \* \*

#### HYDROGRAPHIC OFFICE.

\* \* \* \* \*

Contingent expenses of branch offices at Boston, New York, Philadelphia, Baltimore, Norfolk, Savannah, New Orleans, San Francisco, Portland (Oregon), Portland (Maine), Chicago, Cleveland, Buffalo, Duluth, Sault Sainte Marie, Seattle, Panama, and Galveston, including furniture, fuel, lights, works and periodicals relating to

hydrography, marine meteorology, navigation, surveying, oceanography, and terrestrial magnetism, stationery, miscellaneous articles, rent and care of offices, care of time balls, car fare and ferriage in visiting merchant vessels, freight and express charges, telegrams, and other necessary expenses incurred in collecting the latest information for pilot charts, and for other purposes for which the offices were established, \$10,000.

\* \* \* \* \*

SEC. 4. That no part of any money appropriated by this or any other Act shall be used during the fiscal year nineteen hundred and seventeen for the purchase of any typewriting machine at a price in excess of the lowest price paid by the Government of the United States for the same make and substantially the same model of machine during the fiscal year nineteen hundred and fifteen; such price shall include the value of any typewriting machine or machines given in exchange, but shall not apply to special prices granted on typewriting machines used in schools of the District of Columbia or of the Indian Service, the lowest of which special prices paid for typewriting machines shall not be exceeded in future purchases for such schools: *Providing*, That in construing this section the Commissioner of Patents shall advise the Comptroller of the Treasury as to whether the changes in any typewriter are of such structural character as to constitute a new machine not within the limitations of this section.

\* \* \* \* \*

Approved, May 10, 1916.

AN ACT For making further and more effectual provision for the national defense, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the Army of the United States shall consist of the Regular Army, the Volunteer Army, the Officers' Reserve Corps, the Enlisted Reserve Corps, the National Guard while in the service of the United States, and such other land forces as are now or may hereafter be authorized by law.

\* \* \* \* \*

SEC. 62. NUMBER OF THE NATIONAL GUARD—

\* \* \* \* \*

*Provided further*, That the word Territory as used in this Act and in all laws relating to the land militia and National Guard shall include and apply to Hawaii, Alaska, Porto Rico, and the Canal Zone, and the militia of the Canal Zone shall be organized under such rules and regulations, not in conflict with the provisions of this Act, as the President may prescribe.

\* \* \* \* \*

Approved, June 3, 1916.

AN ACT Making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, nineteen hundred and seventeen, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the following sums are appropriated, out of any money in the Treasury not otherwise appropriated, for the fiscal year ending June thirtieth, nineteen hundred and seventeen, namely:

\* \* \* \* \*

WAR DEPARTMENT.

\* \* \* \* \*

QUARTERMASTER CORPS.

\* \* \* \* \*

Disposition of remains of officers, soldiers, civilian employees, and so forth: For interment, or of preparation and transportation to their homes or to such national cemeteries as may be designated by proper authority, in the discretion of the Secretary of War, of the remains of officers, including acting assistant surgeons and enlisted men of the Army active list; interment, or of preparation and transportation to their homes,

of the remains of civil employees of the Army in the employ of the War Department who die abroad, in Alaska, in the Canal Zone, or on Army transports, or who die while on duty in the field or at military posts within the limits of the United States; interment of military prisoners who die at military posts; removal of remains from abandoned posts to permanent military posts or national cemeteries, including the remains of Federal soldiers, sailors, or marines, interred in fields or abandoned private and city cemeteries; and in any case where the expenses of burial or shipment of the remains of officers or enlisted men of the Army who die on the active list are borne by individuals, where such expenses would have been lawful claims against the Government, reimbursement to such individuals may be made of the amount allowed by the Government for such services out of this sum, but no reimbursement shall be made of such expenses incurred prior to July first, nineteen hundred and ten, \$57,500.

\* \* \* \* \*

#### DEPARTMENT OF COMMERCE.

\* \* \* \* \*

#### COAST AND GEODETIC SURVEY.

Field expenses: For surveys and necessary resurveys of the Atlantic and Gulf coasts of the United States, including the coasts of outlying islands under the jurisdiction of the United States: *Provided*, That not more than \$25,000 of this amount shall be expended on the coasts of said outlying islands, and the Atlantic entrance to the Panama Canal, \$90,000;

\* \* \* \* \*

#### THE PANAMA CANAL.

For every expenditure requisite for and incident to the construction, maintenance and operation, sanitation, and civil government of the Panama Canal and Canal Zone, including the following: Compensation of all officials and employees; foreign and domestic newspapers and periodicals; law books not exceeding \$500, text books and books of reference; printing and binding, including printing of annual report, rents and personal services in the District of Columbia; purchase or exchange of typewriting, adding, and other machines; purchase or exchange, maintenance, repair, and operation of motor-propelled and horse-drawn passenger-carrying vehicles; claims for damages to vessels passing through the locks of the Panama Canal, as authorized by the Panama Canal Act; claims for losses of or damages to property arising from the conduct of authorized business operations; claims for damages caused to owners of private lands or private property of any kind by reason of the grants contained in the treaty between the United States and the Republic of Panama, proclaimed February twenty-sixth, nineteen hundred and four, or by reason of the operations of the United States, its agents or employees, or by reason of the construction, maintenance, operation, sanitation, and protection of the said canal or of the work of sanitation and protection therein provided for, whether such claims are compromised by agreement between the claimants and the Governor of the Panama Canal or allowed by a joint land commission; acquisition of land and land under water, as authorized in the Panama Canal Act; expenses incurred in assembling, assorting, storing, repairing, and selling material, machinery, and equipment heretofore or hereafter purchased or acquired for the construction of the Panama Canal which are unserviceable or no longer needed, to be reimbursed from the proceeds of such sales; expenses incident to conducting hearings and examining estimates for appropriations on the Isthmus; expenses incident to any emergency arising because of calamity by flood, fire, pestilence, or like character not foreseen or otherwise provided for herein; per diem allowance in lieu of subsistence when prescribed by the Governor of the Panama Canal, to persons engaged in field work or traveling on official business, pursuant to section thirteen of the sundry civil appropriation Act approved August first, nineteen hundred and fourteen, and for such other expenses not in the United States as the Governor of the Panama Canal may deem necessary to best promote the construction, maintenance, and operation, sanitation, and civil government of the Panama Canal, all to be expended under the direction of the Governor of the Panama Canal and accounted for as follows:

For continuing the construction and equipment of the Panama Canal, including \$1,000 additional compensation to the Auditor for the War Department for extra services in auditing accounts for the Panama Canal; equipping of colliers *Ulysses* and *Achilles* with self-discharging equipment at not exceeding \$125,000 each and not ex-

ceeding \$50,000 for covering certain unprotected surfaces of said colliers with bitumastic enamel; toward construction by contract or in navy yards complete in every detail, including self-discharging equipment and all other necessary apparatus, of two colliers at a total cost not exceeding \$1,300,000 each under a contract or contracts hereby authorized therefor; also toward construction of one dock at Cristobal (numbered six) at a total cost not exceeding \$1,500,000 under a contract or contracts hereby authorized therefor, \$9,750,000. No part of this sum or of any unexpended balance of appropriations for construction and equipment of the Panama Canal shall be expended for construction or establishment of new quarantine stations.

For maintenance and operation of the Panama Canal, salary of the governor, \$10,000; purchase, inspection, delivery, handling, and storing of material, supplies, and equipment for issue to all departments of the Panama Canal, the Panama Railroad, other branches of the United States Government, and for authorized sales, \$5,750,000, together with all moneys arising from the conduct of business operations authorized by the Panama Canal Act.

For sanitation, quarantine, hospitals, and medical aid and support of the insane and of lepers, and aid and support of indigent persons legally within the Canal Zone including expenses of their deportation when practicable, \$700,000.

For civil government of the Panama Canal and Canal Zone, salaries of district judge \$6,000, district attorney \$5,000, marshal \$5,000, and for gratuities and necessary clothing for indigent discharged prisoners, \$600,000.

In all, \$16,800,000, to be immediately available and to continue available until expended: *Provided*, That all expenditures from the appropriations heretofore, herein, and hereafter made for the construction of the Panama Canal, including any portion of such appropriations which may be used for the construction of dry docks, repair shops, yards, docks, wharves, warehouses, storehouses, and other necessary facilities and appurtenances, for the purpose of providing coal and other materials, labor, repairs, and supplies, for the construction of office buildings and quarters, and other necessary buildings, exclusive of fortifications, colliers, dock six at Cristobal, and reboiling of steamships *Ancon* and *Cristobal*, which steamships shall not be transferred to the Secretary of the Navy, as provided in the Act of May twenty-seventh, nineteen hundred and eight, and exclusive of the fair value of the American legation building in Panama, as approved by the Secretary of War and Secretary of State, which building is authorized to be transferred without charge to the jurisdiction of the Secretary of State, and exclusive of the amount used for operating and maintaining the canal, and exclusive of the amount expended for sanitation and civil government after January first, nineteen hundred and fifteen, may be paid from or reimbursed to the Treasury of the United States out of the proceeds of the sale of bonds authorized in section eight of the said Act approved June twenty-eighth, nineteen hundred and two, and section thirty-nine of the tariff Act approved August fifth, nineteen hundred and nine.

Except in cases of emergency, or conditions arising subsequent to and unforeseen at the time of submitting the annual estimates to Congress, and except for those employed in connection with the construction of permanent quarters, offices, and other necessary buildings, dry docks, repair shops, yards, docks, wharves, warehouses, storehouses, and other necessary facilities and appurtenances for the purpose of providing coal and other materials, labor, repairs, and supplies, and except for the permanent operating organization under which the compensation of the various positions is limited by section four of the Panama Canal Act, there shall not be employed at any time during the fiscal year nineteen hundred and seventeen under any of the foregoing appropriations for the Panama Canal, any greater number of persons than are specified in the notes submitted respectively in connection with the estimates for each of said appropriations in the annual Book of Estimates for said year, nor shall there be paid to any such person during that fiscal year any greater rate of compensation than was authorized to be paid to persons occupying the same or like positions on the first day of July, nineteen hundred and fifteen; and all employments made or compensation increased because of emergencies or conditions so arising shall be specifically set forth, with the reasons therefor, by the governor in his report for the fiscal year nineteen hundred and seventeen.

In addition to the foregoing sums there is appropriated, for the fiscal year nineteen hundred and seventeen, for expenditure and reinvestment under the several heads of appropriation aforesaid without being covered into the Treasury of the United States, all moneys received by the Panama Canal from services rendered or materials and supplies furnished to the United States, the Panama Railroad Company, the Canal Zone government, or to their employees, respectively, or to the Panama Government, from hotel and hospital supplies and services; from rentals, wharriage, and like services; from labor, materials, and supplies and other services furnished to vessels other than those passing through the canal, and to others unable to obtain the same

elsewhere; from the sale of scrap and other by-products of manufacturing and shop operations; from the sale of obsolete and unserviceable material, supplies, and equipment purchased or acquired for the operation, maintenance, protection, sanitation, and government of the canal and Canal Zone; and any net profits accruing from such business to the Panama Canal shall annually be covered into the Treasury of the United States.

In addition there is appropriated for the operation, maintenance, and extension of waterworks, sewers, and pavements in the cities of Panama and Colon, during the fiscal year nineteen hundred and seventeen, the necessary portions of such sums as shall be paid as water rentals or directly by the Government of Panama for such expenses.

#### FORTIFICATIONS, PANAMA CANAL.

For fortifications and armament thereof for the Panama Canal, to be immediately available and to continue available until expended, namely:

For maintenance of clearings and trails, \$30,000.

For protection, preservation, and repair of fortifications, including structures erected for torpedo defense, and for maintaining channels for access to torpedo wharves, \$15,000.

For maintenance and repair of searchlights and electric light and power equipment for fortifications, and for tools, electrical and other supplies, and appliances to be used in their operation, \$7,500.

For the construction of seacoast batteries, \$400,000;

For the construction of mining casemates, cable galleries, torpedo storehouses, cable tanks, and other structures necessary for the operation, preservation, and care of submarine mines and their accessories on the Canal Zone, \$47,000.

For purchase of submarine mines and the necessary appliances to operate them for closing channels leading to the Panama Canal, \$240,000.

For alteration, maintenance, and repair of submarine mine matériel, \$2,500;

For operation and maintenance of fire-control installations at seacoast defenses, \$5,000.

For the purchase, manufacture, and test of seacoast cannon for coast defense, including their carriages, sights, implements, equipments, and the machinery necessary for their manufacture at the arsenals, \$120,000: *Provided*, That the Chief of Ordnance, United States Army, is authorized to enter into contracts or otherwise incur obligations for the purpose above mentioned not to exceed \$180,000 in addition to the appropriations herein and heretofore made.

For the purchase, manufacture, and test of ammunition for seacoast and land defense cannon, including the necessary experiments in connection therewith, and the machinery necessary for its manufacture at the arsenals, \$1,600,000.

For the alteration, maintenance, and installation of the seacoast artillery, including the purchase and manufacture of machinery, tools, and materials necessary for the work, and expenses of civilian mechanics, and extra-duty pay of enlisted men engaged thereon, \$68,000.

For continuing the construction of barracks, quarters, storehouses, and other buildings necessary for accommodating the mobile army and Coast Artillery troops to be stationed there, including water, sewer, and lighting systems, roads, walks, and so forth, and for repairing and remodeling existing buildings to render them suitable for sheltering troops, \$2,000,000;

In all, specifically for fortifications and armament thereof for the Panama Canal, \$4,535,000.

*Provided*, That no part of the appropriations made in this Act shall be available for the salary or pay of any officer, manager, superintendent, foreman, or other person having charge of the work of any employee of the United States while making or causing to be made with a stop watch, or other time-measuring device, a time study of any job of any such employee between the starting and completion thereof, or of the movements of any such employee while engaged upon such works; nor shall any part of the appropriations made in this Act be available to pay any premium or bonus or cash reward to any employee in addition to his regular wages, except for suggestions resulting in improvements or economy in the operation of any Government plant.

SEC. 2. That the Joint Land Commission established under article fifteen of the treaty between the United States and the Republic of Panama, proclaimed February twenty-sixth, nineteen hundred and four, shall not have jurisdiction to adjudicate or settle any claim originating under any lease or contract for occupancy heretofore or hereafter made by the Panama Railroad Company of lands or property owned by said Panama Railroad Company in the Canal Zone, and no part of the moneys appropriated by this or any other Act shall be used to pay such claims.

SEC. 3. That appropriations herein and hereafter made for printing and binding shall not be used for any annual report or the accompanying documents unless the copy therefor is furnished to the Public Printer in the following manner: Copies of the documents accompanying such annual reports on or before the fifteenth day of October of each year; copies of the annual reports on or before the fifteenth day of November of each year; complete revised proofs of the accompanying documents and the annual reports on the tenth and twentieth days of November of each year, respectively; and all of said annual reports and accompanying documents shall be printed, made public, and available for distribution not later than within the first five days after the assembling of each regular session of Congress. The provisions of this section shall not apply to the annual reports of the Smithsonian Institution, the Commissioner of Patents, or the Comptroller of the Currency.

SEC. 4. That the information required in connection with estimates for general or lump-sum appropriations by section ten of the sundry civil appropriation Act, approved August first, nineteen hundred and fourteen, shall be submitted hereafter according to uniform and concise methods which shall be prescribed by the Secretary of the Treasury, but with reference to estimates for pay of mechanics and laborers there shall be submitted in detail only the ratings and trades and the rates per diem paid or to be paid.

SEC. 5. That hereafter at the termination of each fiscal year each Auditor of the Treasury shall report to the Secretary of the Treasury all checks issued by any disbursing officer of the Government as shown by his accounts rendered to such auditor, which shall then have been outstanding and unpaid for three years or more, stating fully in such report the name of the payee, for what purpose each check was given, the office on which drawn, the number of the voucher received therefor, the date, the number and the amount for which it was drawn, and, when known, the residence of the payee. And such reports shall be in lieu of the returns required of disbursing officers by section three hundred and ten of the Revised Statutes.

SEC. 6. That all sums appropriated by this Act for salaries of officers and employees of the Government shall be in full for such salaries for the fiscal year nineteen hundred and seventeen, and all laws or parts of laws to the extent they are in conflict with the provisions of this Act are repealed.

Approved, July 1, 1916.

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AN ACT Making appropriations for the Diplomatic and Consular Service for the fiscal year ending June thirtieth, nineteen hundred and seventeen.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the following sums be, and they are hereby, severally appropriated, in full compensation for the Diplomatic and Consular Service for the fiscal year ending June thirtieth, nineteen hundred and seventeen, out of any money in the Treasury not otherwise appropriated, for the objects hereinafter expressed, namely:

*	*	*	*	*	*	*
PAYMENT TO THE GOVERNMENT OF PANAMA: To enable the Secretary of State to pay to the Government of Panama the fifth annual payment due on February twenty-sixth, nineteen hundred and seventeen, from the Government of the United States to the Government of Panama under article fourteen of the treaty of November eighteenth, nineteen hundred and three, \$250,000.						
*	*	*	*	*	*	*

#### RELIEF AND PROTECTION OF AMERICAN SEAMEN.

Relief and protection of American seamen in foreign countries, and in the Panama Canal Zone, and shipwrecked American seamen in the Territory of Alaska, in the Hawaiian Islands, Porto Rico, and the Philippine Islands, \$40,000.

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Approved, July 1, 1916.

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AN ACT For the relief of Joseph A. Buckholdt.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the Secretary of the Treasury be, and he is hereby, authorized and directed to pay, out of any money in the Treasury not otherwise appropriated, to Joseph A. Buckholdt, of San Antonio, Texas, the sum of \$3,000, in full com-

pensation for injuries received by him by reason of an accident which occurred on January twenty-sixth, nineteen hundred and fourteen, while in the employ of the United States Government on the Panama Canal.

Approved, August 4, 1916.

AN ACT For the relief of Olaf Nelson.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the Secretary of the Treasury be, and he is hereby, authorized and directed to pay to Olaf Nelson, out of any money in the Treasury not otherwise appropriated, the sum of \$1,200, in compensation for injuries sustained on the Panama Canal while in the discharge of his duties.

Approved, August 8, 1916

AN ACT Making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, nineteen hundred and seventeen, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the following sums be, and they are hereby, appropriated, out of any money in the Treasury of the United States not otherwise appropriated, in full compensation for the fiscal year ending June thirtieth, nineteen hundred and seventeen, for the purposes and objects hereinafter expressed, namely:

\* \* \* \* \*

GENERAL EXPENSES. WEATHER BUREAU: For carrying into effect in the District of Columbia and elsewhere in the United States, in the West Indies, in the Panama Canal, the Caribbean Sea, and on adjacent coasts, in the Hawaiian Islands, in Bermuda, and in Alaska, the provisions of an Act approved October first, eighteen hundred and ninety, so far as they relate to the weather service transferred thereby to the Department of Agriculture, \* \* \*

In all, for general expenses, \$1,411,200.

\* \* \* \* \*

Approved, August 11, 1916.

AN ACT Extending certain privileges of canal employees to other officials on the Canal Zone and authorizing the President to make rules and regulations affecting health, sanitation, quarantine, taxation, public roads, self-propelled vehicles, and police powers on the Canal Zone, and for other purposes, including provision as to certain fees, money orders, and interest deposits.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That, until otherwise provided by Congress, the President is authorized to make rules and regulations in matters of sanitation, health, and quarantine for the Canal Zone or to modify or change existing rules and regulations and those hereafter made from time to time. Violations of any quarantine regulations provided for herein shall be punished by fine not to exceed \$500 or by imprisonment in jail not to exceed ninety days, or by both such fine and imprisonment, in the court's discretion; and a violation of any sanitary regulations hereunder shall be punished by a fine not to exceed \$25 or by imprisonment in jail not to exceed thirty days, or by both such fine and imprisonment, in the court's discretion. Each day such violation may continue shall constitute a separate offense.

SEC. 2. That, until otherwise provided by Congress, the President is hereby authorized to make and from time to time change rules and regulations for levying, assessing, and collecting ad valorem, excise, license, and franchise taxes in the Canal Zone, or to modify or change existing rules or regulations for that purpose. Ad valorem taxes imposed shall not exceed one per centum of the value of the property, nor shall franchise or excise taxes exceed two per centum of gross earnings.

SEC. 3. That, until otherwise provided by Congress, it shall be lawful for the President to make, publish, and enforce all rules and regulations for the use of the public roads and highways in the Canal Zone, and also for regulating, licensing, and taxing the use and operation of all self-propelled vehicles using the public highways, including speed limit, signals, tags, license fees, and all detailed regulations which may be from time to time deemed necessary in the exercise of the authority hereby conferred. The taxes on automobiles may be graded according to the value or the power of the machine, and such rules and regulations as now exist may be changed by such order from time to time, and any that may be hereafter made may be changed from time to time. The President may make mutual agreements with the Republic of Panama touching the reciprocal use of the highways of the Canal Zone and the Republic of Panama by self-propelled vehicles touching taxes and



license fees, and any other matter of regulation to establish comity for the convenience of the residents of the two jurisdictions.

SEC. 4. That it shall be unlawful to commit any breach of the peace or engage in or permit any disorderly, indecent, or immoral conduct in the Canal Zone. The President is authorized to enforce this provision by making rules and regulations to assert and exercise the police power in the Canal Zone, or for any portion or division thereof, and he may amend or change any such regulation now existing or hereafter made.

SEC. 5. That any person who commits any act or who carries on any business, trade, or occupation in the Canal Zone without complying with the rules and regulations established by the President for the levying, assessing, and collecting of taxes, or who violates any rules or regulations for the use of the public roads and highways, or who violates any rules and regulations touching the licensing, taxes, operation, and use of self-propelled vehicles, or who violates any of the police regulations authorized hereunder, shall be punished by fine not to exceed \$25 or by imprisonment in jail not to exceed thirty days, or by both such fine and imprisonment, in the court's discretion.

SEC. 6. That deposit money orders issued in the Canal Zone in lieu of postal savings certificates in accordance with the rules and regulations heretofore established by the President, or that may hereafter be established by him, shall bear interest at a rate not exceeding two per centum per annum.

SEC. 7. That the interest received from the Canal Zone money-order funds deposited in banks under Canal Zone regulations shall be available to pay the interest on deposit money orders authorized by the preceding section. Such interest shall also be available to pay any losses which are chargeable to the Canal Zone postal service.

SEC. 8. That whenever a customs officer of the Canal Zone shall certify an invoice, landing certificate, or other similar document, or shall register a marine note of protest, or shall perform any notarial services, he shall be authorized to collect a fee equivalent to the fee prescribed by the United States consular regulations for the same act or service when performed by consular officials.

SEC. 9. The laws relating to seamen of vessels of the United States on foreign voyages shall apply to seamen of all vessels of the United States at the Panama Canal Zone, whether such vessels be registered or enrolled and licensed, and the powers in respect of such seamen of such vessels bestowed by law upon consular officers of the United States in foreign ports and upon shipping commissioners in ports of the United States are hereby bestowed upon the shipping commissioner and deputy shipping commissioners on the Panama Canal Zone.

SEC. 10. The President is hereby authorized to make rules and regulations, and to alter or amend the same from time to time, touching the right of any person to enter or remain upon or pass over any part of the Canal Zone; for the detention of any person entering the Canal Zone in violation of such rules and regulations, and return of such person to the country whence he or she came, on the vessel bringing such person to the Canal Zone, or any other vessel belonging to the same owner or interest, and at the expense of such owner or interest; and in addition to the punishment prescribed by this section for violation of any such rules and regulations, the authorities of the Canal Zone may withhold the clearance of such vessel from any port in the Canal Zone until any fine imposed and the cost of maintenance of such person are paid. Any person violating any of such rules or regulations shall be guilty of a misdemeanor, and on conviction in the district court of the Canal Zone shall be punished by a fine not exceeding \$500 or by imprisonment not exceeding a year, or both in the discretion of the court. It shall be unlawful for any person, by any means or in any way, to injure or obstruct or attempt to injure or obstruct, any part of the Panama Canal or the locks thereof or the approaches thereto. Any person violating this provision shall be guilty of a felony, and on conviction in the district court of the Canal Zone shall be punished by a fine not exceeding \$10,000 or by imprisonment not exceeding twenty years, or both, in the discretion of the court. If the act shall cause the death of any person within a year and a day thereafter, the person so convicted shall be guilty of murder and shall be punished accordingly.

SEC. 11. That all laws, orders, or ordinances in conflict with this Act are hereby repealed.

Approved, August 21, 1916.

AN ACT Making appropriations for the support of the Army for the fiscal year ending June thirtieth, nineteen hundred and seventeen, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the following sums be, and they are hereby, appropriated, out of any money in the Treasury not otherwise appropriated, for the support of the Army for the year ending June thirtieth, nineteen hundred and seventeen.

\* \* \* \* \*

## PAY OF OFFICERS OF THE LINE.

\* \* \* \* \*

*And provided further,* That the general officers of the line who were appointed as such pursuant to the Act of March fourth, nineteen hundred and fifteen (Thirty-eighth Statutes at Large, page eleven hundred and ninety-one), shall take rank in their present grades over all officers hereafter appointed to like grades.

\* \* \* \* \*

## BARRACKS AND QUARTERS.

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*Provided further,* That the Secretary of War is authorized to expend from the above amount not to exceed \$110,000 for the purpose of providing temporary shelter on the Canal Zone for one regiment of Infantry and one company of Engineers.

\* \* \* \* \*

## MEDICAL DEPARTMENT.

**MEDICAL AND HOSPITAL DEPARTMENT:** For the purchase of medical and hospital supplies, including motor ambulances, and motorcycles for medical service, their maintenance, repair, and operation, and disinfectants, and the exchange of type-writing machines, for military posts, camps, hospitals, hospital ships and transports, and supplies required for mosquito destruction in and about the military posts in the Canal Zone: \* \* \* \$4,500,000.

\* \* \* \* \*

**HOSPITAL CARE, CANAL ZONE GARRISONS:** For paying the Panama Canal such reasonable charges, exclusive of subsistence, as may be approved by the Secretary of War for caring in its hospitals for officers, enlisted men, military prisoners, and civilian employees of the Army admitted thereto upon the request of proper military authority: *Provided,* That the subsistence of the said patients, except commissioned officers and acting dental surgeons, shall be paid to said hospitals out of the appropriation for subsistence of the Army at the rates provided therein for commutation of rations for enlisted patients in general hospitals, \$45,000.

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Approved, August 29, 1916.

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AN ACT Making appropriations for the naval service for the fiscal year ending June thirtieth, nineteen hundred and seventeen, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the following sums be, and they are hereby, appropriated, to be paid out of any money in the Treasury not otherwise appropriated, for the naval service of the Government for the year ending June thirtieth, nineteen hundred and seventeen, and for other purposes:

\* \* \* \* \*

Section six of an Act entitled "An Act making appropriations for the legislative, executive, and judicial expenses of the Government for the fiscal year ending June thirtieth, nineteen hundred and seventeen, namely:" approved May tenth, nineteen hundred and sixteen, is hereby amended so as to read as follows:

"SEC. 6. That unless otherwise specially authorized by law, no money appropriated by this or any other Act shall be available for payment to any person receiving more than one salary when the combined amount of said salaries exceeds the sum of \$2,000 per annum, but this shall not apply to retired officers or enlisted men of the Army, Navy, Marine Corps, or Coast Guard, or to officers and enlisted men of the Organized Militia and Naval Militia in the several States, Territories, and the District of Columbia: *Provided,* That no such retired officer, officer, or enlisted man shall be denied or deprived of any of his pay, salary, or compensation as such, or of any other salary or compensation for services heretofore rendered, by reason of any decision or construction of said section six."

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BUREAU OF CONSTRUCTION AND REPAIR.

\* \* \* \* \*

Installing gun foundations on Panama Canal colliers Ulysses and Achilles, \$10,071,069.16.

BUREAU OF STEAM ENGINEERING.

\* \* \* \* \*

High-power radio stations: For the completion of high-power radio stations (cost not to exceed \$1,500,000), to be located as follows: One in the Isthmian Canal Zone, one on the California coast, one in the Hawaiian Islands, one in American Samoa, one on the island of Guam, and one in the Philippine Islands, \$300,000, to be available until expended.

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Approved, August 29, 1916.

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AN ACT To provide compensation for employees of the United States suffering injuries while in the performance of their duties, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the United States shall pay compensation as hereinafter specified for the disability or death of an employee resulting from a personal injury sustained while in the performance of his duty, but no compensation shall be paid if the injury or death is caused by the willful misconduct of the employee or by the employee's intention to bring about the injury or death of himself or of another, or if intoxication of the injured employee is the proximate cause of the injury or death.

SEC. 2. That during the first three days of disability the employee shall not be entitled to compensation except as provided in section nine. No compensation shall at any time be paid for such period.

SEC. 3. That if the disability is total the United States shall pay to the disabled employee during such disability a monthly compensation equal to sixty-six and two-thirds per centum of his monthly pay, except as hereinafter provided.

SEC. 4. That if the disability is partial the United States shall pay to the disabled employee during such disability a monthly compensation equal to sixty-six and two-thirds per centum of the difference between his monthly pay and his monthly wage-earning capacity after the beginning of such partial disability. The commission may, from time to time, require a partially disabled employee to make an affidavit as to the wages which he is then receiving. In such affidavit the employee shall include a statement of the value of housing, board, lodging, and other advantages which are received from the employer as a part of his remuneration and which can be estimated in money. If the employee, when required, fails to make such affidavit, he shall not be entitled to any compensation while such failure continues, and the period of such failure shall be deducted from the period during which compensation is payable to him.

SEC. 5. That if a partially disabled employee refuses to seek suitable work or refuses or neglects to work after suitable work is offered to, procured by, or secured for him, he shall not be entitled to any compensation.

SEC. 6. That the monthly compensation for total disability shall not be more than \$66.67 nor less than \$33.33, unless the employee's monthly pay is less than \$33.33, in which case his monthly compensation shall be the full amount of his monthly pay. The monthly compensation for partial disability shall not be more than \$66.67. In the case of persons who at the time of the injury were minors or employed in a learner's capacity and who were not physically or mentally defective, the commission shall, on any review after the time when the monthly wage-earning capacity of such persons would probably, but for the injury, have increased, award compensation based on such probable monthly wage-earning capacity. The commission may, on any review after the time when the monthly wage-earning capacity of the disabled employee would probably, irrespective of the injury, have decreased on account of old age, award compensation based on such probable monthly wage-earning capacity.

SEC. 7. That as long as the employee is in receipt of compensation under this Act, or, if he has been paid a lump sum in commutation of installment payments, until the expiration of the period during which such installment payments would have continued, he shall not receive from the United States any salary, pay, or remuneration whatsoever except in return for services actually performed, and except pensions for service in the Army or Navy of the United States.

SEC. 8. That if at the time the disability begins the employee has annual or sick leave to his credit he may, subject to the approval of the head of the department, use such leave until it is exhausted, in which case his compensation shall begin on the fourth day of disability after the annual or sick leave has ceased.

SEC. 9. That immediately after an injury sustained by an employee while in the performance of his duty, whether or not disability has arisen, and for a reasonable time thereafter, the United States shall furnish to such employee reasonable medical, surgical, and hospital services and supplies unless he refuses to accept them. Such services and supplies shall be furnished by United States medical officers and hospitals, but where this is not practicable shall be furnished by private physicians and hospitals designated or approved by the commission and paid for from the employees' compensation fund. If necessary for the securing of proper medical, surgical, and hospital treatment, the employee, in the discretion of the commission, may be furnished transportation at the expense of the employees' compensation fund.

SEC. 10. That if death results from the injury within six years the United States shall pay to the following persons for the following periods a monthly compensation equal to the following percentages of the deceased employee's monthly pay, subject to the modification that no compensation shall be paid where the death takes place more than one year after the cessation of disability resulting from such injury, or, if there has been no disability preceding death, more than one year after the injury:

(A) To the widow, if there is no child, thirty-five per centum. This compensation shall be paid until her death or marriage.

(B) To the widower, if there is no child, thirty-five per centum if wholly dependent for support upon the deceased employee at the time of her death. This compensation shall be paid until his death or marriage.

(C) To the widow or widower, if there is a child, the compensation payable under clause (A) or clause (B) and in addition thereto ten per centum for each child, not to exceed a total of sixty-six and two-thirds per centum for such widow or widower and children. If a child has a guardian other than the surviving widow or widower, the compensation payable on account of such child shall be paid to such guardian. The compensation payable on account of any child shall cease when he dies, marries, or reaches the age of eighteen, or, if over eighteen, and incapable of self-support, becomes capable of self-support.

(D) To the children, if there is no widow or widower, twenty-five per centum for one child and ten per centum additional for each additional child, not to exceed a total of sixty-six and two-thirds per centum, divided among such children share and share alike. The compensation of each child shall be paid until he dies, marries, or reaches the age of eighteen, or, if over eighteen and incapable of self-support, becomes capable of self-support. The compensation of a child under legal age shall be paid to its guardian.

(E) To the parents, if one is wholly dependent for support upon the deceased employee at the time of his death and the other is not dependent to any extent, twenty-five per centum; if both are wholly dependent, twenty per centum to each; if one is or both are partly dependent, a proportionate amount in the discretion of the commission.

The above percentages shall be paid if there is no widow, widower, or child. If there is a widow, widower, or child, there shall be paid so much of the above percentages as, when added to the total percentages payable to the widow, widower, and children, will not exceed a total of sixty-six and two-thirds per centum.

(F) To the brothers, sisters, grandparents, and grandchildren, if one is wholly dependent upon the deceased employee for support at the time of his death, twenty per centum to such dependent; if more than one are wholly dependent, thirty per centum, divided among such dependents share and share alike; if there is no one of them wholly dependent, but one or more partly dependent, ten per centum divided among such dependents share and share alike.

The above percentages shall be paid if there is no widow, widower, child, or dependent parent. If there is a widow, widower, child, or dependent parent, there shall be paid so much of the above percentages as, when added to the total percentage payable to the widow, widower, children, and dependent parents, will not exceed a total of sixty-six and two-thirds per centum.

(G) The compensation of each beneficiary under clauses (E) and (F) shall be paid for a period of eight years from the time of the death, unless before that time he, if a parent or grandparent, dies, marries, or ceases to be dependent, or, if a brother, sister, or grandchild, dies, marries, or reaches the age of eighteen, or, if over eighteen and incapable of self-support, becomes capable of self-support. The compensation of a brother, sister, or grandchild under legal age shall be paid to his or her guardian.

(H) As used in this section, the term "child" includes stepchildren, adopted children, and posthumous children, but does not include married children. The terms "brother" and "sister" include stepbrothers and stepsisters, half brothers and half sisters, and brothers and sisters by adoption, but do not include married brothers or married sisters. All of the above terms and the term "grandchild" include only persons who at the time of the death of the deceased employee are under eighteen years of age or over that age and incapable of self-support. The term "parent" includes stepparents and parents by adoption. The term "widow" includes only the decedent's wife living with or dependent for support upon him at the time of his death. The term "widower" includes only the decedent's husband dependent for support upon her at the time of her death. The terms "adopted" and "adoption" as used in this clause include only legal adoption prior to the time of the injury.

(I) Upon the cessation of compensation under this section to or on account of any person, the compensation of the remaining persons entitled to compensation for the unexpired part of the period during which their compensation is payable shall be that which such persons would have received if they had been the only persons entitled to compensation at the time of the decedent's death.

(J) In case there are two or more classes of persons entitled to compensation under this section and the apportionment of such compensation, above provided, would result in injustice, the commission may in its discretion, modify the apportionment to meet the requirements of the case.

(K) In computing compensation under this section, the monthly pay shall be considered not to be more than \$100 nor less than \$50, but the total monthly compensation shall not exceed the monthly pay computed as provided in section twelve.

(L) If any person entitled to compensation under this section, whose compensation by the terms of this section ceases upon his marriage, accepts any payments of compensation after his marriage he shall be punished by a fine of not more than \$2,000 or by imprisonment for not more than one year, or by both such fine and imprisonment.

SEC. 11. That if death results from the injury within six years the United States shall pay to the personal representative of the deceased employee burial expenses not to exceed \$100, in the discretion of the commission. In the case of an employee whose home is within the United States, if his death occurs away from his home office or outside of the United States, and if so desired by his relatives, the body shall, in the discretion of the commission, be embalmed and transported in a hermetically sealed casket to the home of the employee. Such burial expenses shall not be paid and such transportation shall not be furnished where the death takes place more than one year after the cessation of disability resulting from such injury, or, if there has been no disability preceding death, more than one year after the injury.

SEC. 12. That in computing the monthly pay the usual practice of the service in which the employee was employed shall be followed. Subsistence and the value of quarters furnished an employee shall be included as part of the pay, but overtime pay shall not be taken into account.

SEC. 13. That in the determination of the employee's monthly wage-earning capacity after the beginning of partial disability, the value of housing, board, lodging, and other advantages which are received from his employer as a part of his remuneration and which can be estimated in money shall be taken into account.

SEC. 14. That in cases of death or of permanent total or permanent partial disability, if the monthly payment to the beneficiary is less than \$5 a month, or if the beneficiary is or is about to become a nonresident of the United States, or if the commission determines that it is for the best interests of the beneficiary, the liability of the United States for compensation to such beneficiary may be discharged by the payment of a lump sum equal to the present value of all future payments of compensation computed at four per centum true discount compounded annually. The probability of the beneficiary's death before the expiration of the period during which he is entitled to compensation shall be determined according to the American Experience Table of Mortality; but in case of compensation to the widow or widower of the deceased employee, such lump sum shall not exceed sixty months' compensation. The probability of the happening of any other contingency affecting the amount or duration of the compensation shall be disregarded.

SEC. 15. That every employee injured in the performance of his duty, or some one on his behalf, shall, within forty-eight hours after the injury, give written notice thereof to the immediate superior of the employee. Such notice shall be given by delivering it personally or by depositing it properly stamped and addressed in the mail.

SEC. 16. That the notice shall state the name and address of the employee, the year, month, day, and hour when and the particular locality where the injury occurred,

and the cause and nature of the injury, and shall be signed by and contain the address of the person giving the notice.

Sec. 17. That unless notice is given within the time specified or unless the immediate superior has actual knowledge of the injury, no compensation shall be allowed, but for any reasonable cause shown, the commission may allow compensation if the notice is filed within one year after the injury.

Sec. 18. That no compensation under this Act shall be allowed to any person, except as provided in section thirty-eight, unless he or some one on his behalf shall, within the time specified in section twenty, make a written claim therefor. Such claim shall be made by delivering it at the office of the commission or to any commissioner or to any person whom the commission may by regulation designate, or by depositing it in the mail properly stamped and addressed to the commission or to any person whom the commission may by regulation designate.

Sec. 19. That every claim shall be made on forms to be furnished by the commission and shall contain all the information required by the commission. Each claim shall be sworn to by the person entitled to compensation or by the person acting on his behalf, and, except in case of death, shall be accompanied by a certificate of the employee's physician stating the nature of the injury and the nature and probable extent of the disability. For any reasonable cause shown the commission may waive the provisions of this section.

Sec. 20. That all original claims for compensation for disability shall be made within sixty days after the injury. All original claims for compensation for death shall be made within one year after the death. For any reasonable cause shown the commission may allow original claims for compensation for disability to be made at any time within one year.

Sec. 21. That after the injury the employee shall, as frequently and at such times and places as may be reasonably required, submit himself to examination by a medical officer of the United States or by a duly qualified physician designated or approved by the commission. The employee may have a duly qualified physician designated and paid by him present to participate in such examination. For all examinations after the first the employee shall, in the discretion of the commission, be paid his reasonable traveling and other expenses and loss of wages incurred in order to submit to such examination. If the employee refuses to submit himself for or in any way obstructs any examination, his right to claim compensation under this Act shall be suspended until such refusal or obstruction ceases. No compensation shall be payable while such refusal or obstruction continues, and the period of such refusal or obstruction shall be deducted from the period for which compensation is payable to him.

Sec. 22. That in case of any disagreement between the physician making an examination on the part of the United States and the employee's physician the commission shall appoint a third physician, duly qualified, who shall make an examination.

Sec. 23. That fees for examinations made on the part of the United States under sections twenty-one and twenty-two by physicians who are not already in the service of the United States shall be fixed by the commission. Such fees, and any sum payable to the employee under section twenty-one, shall be paid out of the appropriation for the work of the commission.

Sec. 24. That immediately after an injury to an employee resulting in his death or in his probable disability, his immediate superior shall make a report to the commission containing such information as the commission may require, and shall thereafter make such supplementary reports as the commission may require.

Sec. 25. That any assignment of a claim for compensation under this Act shall be void and all compensation and claims therefor shall be exempt from all claims of creditors.

Sec. 26. If an injury or death for which compensation is payable under this Act is caused under circumstances creating a legal liability upon some person other than the United States to pay damages therefor, the commission may require the beneficiary to assign to the United States any right of action he may have to enforce such liability of such other person or any right which he may have to share in any money or other property received in satisfaction of such liability of such other person, or the commission may require said beneficiary to prosecute said action in his own name.

If the beneficiary shall refuse to make such assignment or to prosecute said action in his own name when required by the commission, he shall not be entitled to any compensation under this Act.

The cause of action when assigned to the United States may be prosecuted or compromised by the commission, and if the commission realizes upon such cause of action, it shall apply the money or other property so received in the following manner: After deducting the amount of any compensation already paid to the beneficiary and the expenses of such realization or collection, which sum shall be placed to the credit of

the employees' compensation fund, the surplus, if any, shall be paid to the beneficiary and credited upon any future payments of compensation payable to him on account of the same injury.

SEC. 27. That if an injury or death for which compensation is payable under this Act is caused under circumstances creating a legal liability in some person other than the United States to pay damages therefor, and a beneficiary entitled to compensation from the United States for such injury or death receives, as a result of a suit brought by him or on his behalf, or as a result of a settlement made by him or on his behalf, any money or other property in satisfaction of the liability of such other person, such beneficiary shall, after deducting the costs of suit and a reasonable attorney's fee, apply the money or other property so received in the following manner:

(A) If his compensation has been paid in whole or in part, he shall refund to the United States the amount of compensation which has been paid by the United States and credit any surplus upon future payments of compensation payable to him on account of the same injury. Any amount so refunded to the United States shall be placed to the credit of the employees' compensation fund.

(B) If no compensation has been paid to him by the United States, he shall credit the money or other property so received upon any compensation payable to him by the United States on account of the same injury.

SEC. 28. That a commission is hereby created, to be known as the United States Employees' Compensation Commission, and to be composed of three commissioners appointed by the President, by and with the advice and consent of the Senate, one of whom shall be designated by the President as chairman. No commissioner shall hold any other office or position under the United States. No more than two of said commissioners shall be members of the same political party. One of said commissioners shall be appointed for a term of two years, one for a term of four years, and one for a term of six years, and at the expiration of each of said terms, the commissioner then appointed shall be appointed for a period of six years. Each commissioner shall receive a salary of \$4,000 a year. The principal office of said commission shall be in Washington, District of Columbia, but the said commission is authorized to perform its work at any place deemed necessary by said commission, subject to the restrictions and limitations of this Act.

SEC. 28a. Upon the organization of said commission and notification to the heads of all executive departments that the commission is ready to take up the work devolved upon it by this Act, all commissions and independent bureaus, by or in which payments for compensation are now provided, together with the adjustment and settlement of such claims, shall cease and determine, and such executive departments, commissions, and independent bureaus shall transfer all pending claims to said commission to be administered by it. The said commission may obtain, in all cases, in addition to the reports provided in section twenty-four, such information and such reports from employees of the departments as may be agreed upon by the commission and the heads of the respective departments. All clerks and employees now exclusively engaged in carrying on said work in the various executive departments, commissions, and independent bureaus, shall be transferred to, and become employees of, the commission at their present grades and salaries.

SEC. 29. That the commission, or any commissioner by authority of the commission, shall have power to issue subpoenas for and compel the attendance of witnesses within a radius of one hundred miles, to require the production of books, papers, documents, and other evidence, to administer oaths, and to examine witnesses, upon any matter within the jurisdiction of the commission.

SEC. 30. That the commission shall have such assistants, clerks, and other employees as may be from time to time provided by Congress. They shall be appointed from lists of eligibles to be supplied by the Civil Service Commission, and in accordance with the civil-service law.

SEC. 31. That the commission shall submit annually to the Secretary of the Treasury estimates of the appropriations necessary for the work of the commission.

SEC. 32. That the commission is authorized to make necessary rules and regulations for the enforcement of this Act, and shall decide all questions arising under this Act.

SEC. 33. That the commission shall make to Congress at the beginning of each regular session a report of its work for the preceding fiscal year, including a detailed statement of appropriations and expenditures, a detailed statement showing receipts of and expenditures from the employees' compensation fund, and its recommendations for legislation.

SEC. 34. That for the fiscal year ending June thirtieth, nineteen hundred and seventeen, there is hereby authorized to be appropriated, from any money in the Treasury not otherwise appropriated, the sum of \$50,000 for the work of the commission,



including salaries of the commissioners and of such assistants, clerks, and other employees as the commission may deem necessary, and for traveling expenses, expenses of medical examinations under sections twenty-one and twenty-two, reasonable traveling and other expenses and loss of wages payable to employees under section twenty-one, rent and equipment of offices, purchase of books, stationery, and other supplies, printing and binding to be done at the Government Printing Office, and other necessary expenses.

SEC. 35. That there is hereby authorized to be appropriated, from any money in the Treasury not otherwise appropriated, the sum of \$500,000, to be set aside as a separate fund in the Treasury, to be known as the employees' compensation fund. To this fund there shall be added such sums as Congress may from time to time appropriate for the purpose. Such fund, including all additions that may be made to it, is hereby authorized to be permanently appropriated for the payment of the compensation provided by this Act, including the medical, surgical, and hospital services and supplies provided by section nine, and the transportation and burial expenses provided by sections nine and eleven. The commission shall submit annually to the Secretary of the Treasury estimates of the appropriations necessary for the maintenance of the fund.

SEC. 36. The commission, upon consideration of the claim presented by the beneficiary, and the report furnished by the immediate superior and the completion of such investigation as it may deem necessary, shall determine and make a finding of facts thereon and make an award for or against payment of the compensation provided for in this Act. Compensation when awarded shall be paid from the employees' compensation fund.

SEC. 37. That if the original claim for compensation has been made within the time specified in section twenty, the commission may, at any time, on its own motion or on application, review the award, and, in accordance with the facts found on such review, may end, diminish, or increase the compensation previously awarded, or, if compensation has been refused or discontinued, award compensation.

SEC. 38. That if any compensation is paid under a mistake of law or of fact, the commission shall immediately cancel any award under which such compensation has been paid and shall recover, as far as practicable, any amount which has been so paid. Any amount so recovered shall be placed to the credit of the employees' compensation fund.

SEC. 39. That whoever makes, in any affidavit required under section four or in any claim for compensation, any statement, knowing it to be false, shall be guilty of perjury and shall be punished by a fine of not more than \$2,000, or by imprisonment for not more than one year, or by both such fine and imprisonment.

SEC. 40. That wherever used in this Act—

The singular includes the plural and the masculine includes the feminine.

The term "employee" includes all civil employees of the United States and of the Panama Railroad Company.

The term "commission" shall be taken to refer to the United States Employees' Compensation Commission provided for in section twenty-eight.

The term "physician" includes surgeons.

The term "monthly pay" shall be taken to refer to the monthly pay at the time of the injury.

SEC. 41. That all Acts or parts of Acts inconsistent with this Act are hereby repealed: *Provided, however*, That for injuries occurring prior to the passage of this Act compensation shall be paid under the law in force at the time of the passage of this Act: *And provided further*, That if an injury or death for which compensation is payable under this Act is caused under circumstances creating a legal liability in the Panama Railroad Company to pay damages therefor under the laws of any State, Territory, or possession of the United States or of the District of Columbia or of any foreign country, no compensation shall be payable until the person entitled to compensation releases to the Panama Railroad Company any right of action which he may have to enforce such liability of the Panama Railroad Company, or until he assigns to the United States any right which he may have to share in any money or other property received in satisfaction of such liability of the Panama Railroad Company.

SEC. 42. That the President may, from time to time, transfer the administration of this Act so far as employees of the Panama Canal and of the Panama Railroad Company are concerned to the governor of the Panama Canal, and so far as employees of the Alaskan Engineering Commission are concerned to the chairman of that commission, in which cases the words "commission" and "its" wherever they appear in this Act shall, so far as necessary to give effect to such transfer, be read "governor of the Panama Canal" or "chairman of the Alaskan Engineering Commission," as the case may be, and "his"; and the expenses of medical examinations under sections twenty-one and



twenty-two, and the reasonable traveling and other expenses and loss of wages payable to employees under section twenty-one, shall be paid out of appropriations for the Panama Canal or for the Alaskan Engineering Commission or out of funds of the Panama Railroad, as the case may be, instead of out of the appropriation for the work of the commission.

In the case of compensation to employees of the Panama Canal or of the Panama Railroad Company for temporary disability, either total or partial, the President may authorize the governor of the Panama Canal to waive, at his discretion, the making of the claim required by section eighteen. In the case of alien employees of the Panama Canal or of the Panama Railroad Company, or of any class or classes of them, the President may remove or modify the minimum limit established by section six on the monthly compensation for disability and the minimum limit established by clause (K) of section ten on the monthly pay on which death compensation is to be computed. The President may authorize the governor of the Panama Canal and the chairman of the Alaskan Engineering Commission to pay the compensation provided by this Act, including the medical, surgical, and hospital services and supplies provided by section nine and the transportation and burial expenses provided by sections nine and eleven, out of the appropriations for the Panama Canal and for the Alaskan Engineering Commission, such appropriations to be reimbursed for such payments by the transfer of funds from the employees' compensation fund.

Approved, September 7, 1916.

AN ACT To establish a United States Shipping Board for the purpose of encouraging, developing, and creating a naval auxiliary and naval reserve and a merchant marine to meet the requirements of the commerce of the United States with its Territories and possessions and with foreign countries; to regulate carriers by water engaged in the foreign and interstate commerce of the United States; and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*

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 SEC. 5. That the board, with the approval of the President, is authorized to have constructed and equipped in American shipyards and navy yards or elsewhere, giving preference, other things being equal, to domestic yards, or to purchase, lease, or charter, vessels suitable, as far as the commercial requirements of the marine trade of the United States may permit, for use as naval auxiliaries or Army transports, or for other naval or military purposes, and to make necessary repairs on and alterations of such vessels: *Provided*, That neither the board nor any corporation formed under section eleven in which the United States is then a stockholder shall purchase, lease, or charter any vessel—

(a) Which is then engaged in the foreign or domestic commerce of the United States, unless it is about to be withdrawn from such commerce without any intention on the part of the owner to return it thereto within a reasonable time;

(b) Which is under the registry or flag of a foreign country which is then engaged in war;

(c) Which is not adapted, or can not by reasonable alterations and repairs be adapted, to the purposes specified in this section;

(d) Which, upon expert examination made under the direction of the board, a written report of such examination being filed as a public record, is not without alteration or repair found to be at least seventy-five per centum as efficient as at the time it was originally put in commission as a seaworthy vessel.

SEC. 6. That the President may transfer either permanently or for limited periods to the board such vessels belonging to the War or Navy Department as are suitable for commercial uses and not required for military or naval use in time of peace, and cause to be transferred to the board vessels owned by the Panama Railroad Company and not required in its business.

SEC. 7. That the board, upon terms and conditions prescribed by it and approved by the President, may charter, lease, or sell to any person, a citizen of the United States, any vessel so purchased, constructed, or transferred.

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 SEC. 9. That any vessel purchased, chartered, or leased from the board may be registered or enrolled and licensed, or both registered and enrolled and licensed, as a vessel of the United States and entitled to the benefits and privileges appertaining thereto: *Provided*, That foreign-built vessels admitted to American registry or enrollment and license under this Act, and vessels owned, chartered, or leased by any corporation in which the United States is a stockholder, and vessels sold, leased, or chartered to any person a citizen of the United States, as provided in this Act, may engage in the coastwise trade of the United States.

Every vessel purchased, chartered, or leased from the board shall, unless otherwise authorized by the board, be operated only under such registry or enrollment and license. Such vessels while employed solely as merchant vessels shall be subject to all laws, regulations, and liabilities governing merchant vessels, whether the United States be interested therein as owner, in whole or in part, or hold any mortgage, lien, or other interest therein. No such vessel, without the approval of the board, shall be transferred to a foreign registry or flag, or sold; nor, except under regulations prescribed by the board, be chartered or leased.

When the United States is at war, or during any national emergency the existence of which is declared by proclamation of the President, no vessel registered or enrolled and licensed under the laws of the United States shall, without the approval of the board, be sold, leased, or chartered to any person not a citizen of the United States, or transferred to a foreign registry or flag. No vessel registered or enrolled and licensed under the laws of the United States, or owned by any person a citizen of the United States, except one which the board is prohibited from purchasing, shall be sold to any person not a citizen of the United States or transferred to a foreign registry or flag, unless such vessel is first tendered to the board at the price in good faith offered by others, or, if no such offer, at a fair price to be determined in the manner provided in section ten.

Any vessel sold, chartered, leased, transferred, or operated in violation of this section shall be forfeited to the United States, and whoever violates any provision of this section shall be guilty of a misdemeanor and subject to a fine of not more than \$5,000 or to imprisonment of not more than five years, or both such fine and imprisonment.

SEC. 10. That the President, upon giving to the person interested such reasonable notice in writing as in his judgment the circumstances permit, may take possession, absolutely or temporarily, for any naval or military purpose, of any vessel purchased, leased, or chartered from the board: *Provided*, That if, in the judgment of the President, an emergency exists requiring such action he may take possession of any such vessel without notice.

Thereafter, upon ascertainment by agreement or otherwise, the United States shall pay the person interested the fair actual value based upon normal conditions at the time of taking of the interest of such person in every vessel taken absolutely, or if taken for a limited period, the fair charter value under normal conditions for such period. In case of disagreement as to such fair value it shall be determined by appraisers, one to be appointed by the board, one by the person interested, and a third by the two so appointed. The finding of such appraisers shall be final and binding upon both parties.

SEC. 11. That the board, if in its judgment such action is necessary to carry out the purposes of this Act, may form under the laws of the District of Columbia one or more corporations for the purchase, construction, equipment, lease, charter, maintenance, and operation of merchant vessels in the commerce of the United States. The total capital stock thereof shall not exceed \$50,000,000. The board may, for and on behalf of the United States, subscribe to, purchase, and vote not less than a majority of the capital stock of any such corporation, and do all other things in regard thereto necessary to protect the interests of the United States and to carry out the purposes of this Act. The board, with the approval of the President, may sell any or all of the stock of the United States in such corporation, but at no time shall it be a minority stockholder therein: *Provided*, That no corporation in which the United States is a stockholder, formed under the authority of this section, shall engage in the operation of any vessel constructed, purchased, leased, chartered, or transferred under the authority of this Act unless the board shall be unable, after a bona fide effort, to contract with any person a citizen of the United States for the purchase, lease, or charter of such vessel under such terms and conditions as may be prescribed by the board.

The board shall give public notice of the fact that vessels are offered and the terms and conditions upon which a contract will be made, and shall invite competitive offerings. In the event the board shall, after full compliance with the terms of this proviso, determine that it is unable to enter into a contract with such private parties for the purchase, lease, or charter of such vessel, it shall make a full report to the President, who shall examine such report, and if he shall approve the same he shall make an order declaring that the conditions have been found to exist which justify the operation of such vessel by a corporation formed under the provisions of this section.

At the expiration of five years from the conclusion of the present European war the operation of vessels on the part of any such corporation in which the United States is then a stockholder shall cease and the said corporation stand dissolved. The date of the conclusion of the war shall be declared by proclamation of the President. The vessels and other property of any such corporation shall revert to the

board. The board may sell, lease, or charter such vessels as provided in section seven and shall dispose of the property other than vessels on the best available terms and, after payment of all debts and obligations, deposit the proceeds thereof in the Treasury to its credit. All stock in such corporations owned by others than the United States at the time of dissolution shall be taken over by the board at a fair and reasonable value and paid for with funds to the credit of the board. In case of disagreement, such value shall be determined in the manner provided in section ten.

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SEC. 13. That for the purpose of carrying out the provisions of sections five and eleven no liability shall be incurred exceeding a total of \$50,000,000 and the Secretary of the Treasury, upon the request of the board, approved by the President, shall from time to time issue and sell or use any of the bonds of the United States now available in the Treasury under the Acts of August fifth, nineteen hundred and nine, February fourth, nineteen hundred and ten, and March second, nineteen hundred and eleven, relating to the issue of bonds for the construction of the Panama Canal, to a total amount not to exceed \$50,000,000: *Provided*, That any bonds issued and sold or used under the provisions of this section may be made payable at such time within fifty years after issue as the Secretary of the Treasury may fix, instead of fifty years after the date of issue, as prescribed in the Act of August fifth, nineteen hundred and nine.

The proceeds of such bonds and the net proceeds of all sales, charters, and leases of vessels and of sales of stock made by the board, and all other moneys received by it from any source, shall be covered into the Treasury to the credit of the board, and are hereby permanently appropriated for the purpose of carrying out the provisions of sections five and eleven.

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Approved, September 7, 1916.

AN ACT Making appropriations to supply deficiencies in appropriations for the fiscal year ending June thirtieth, nineteen hundred and sixteen, and prior fiscal years, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the following sums are appropriated, out of any money in the Treasury not otherwise appropriated, to supply deficiencies in appropriations for the fiscal year ending June thirtieth, nineteen hundred and sixteen, and prior fiscal years, and for other purposes, namely:

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#### DEPARTMENT OF STATE.

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Relief and protection of American seamen: For relief and protection of American seamen in foreign countries, and shipwrecked American seamen in the Territory of Alaska, in the Hawaiian Islands, Porto Rico, the Panama Canal Zone, and the Philippine Islands, \$15,000.

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#### PANAMA CANAL.

The authorized cost of construction, by contract or in navy yards, complete in every detail, including self-discharging equipment and all other necessary apparatus, of two colliers for the Panama Canal provided for in the sundry civil appropriation Act for the fiscal year nineteen hundred and seventeen, is increased from \$1,300,000 each to \$1,500,000 each.

#### FORTIFICATIONS.

Ordnance depot:

For three storehouses, \$90,000;

For two magazine buildings, \$20,000;

For one magazine building, \$6,000;

For one shop building, \$17,000;

For one office building, \$4,000;

For one barrack, \$17,350;

For one set of field officers' quarters, \$16,800;

For one set of captains' quarters, \$15,750;

For one set of double noncommissioned officers' quarters, \$12,600;

For seven sets of family quarters for personnel of Ordnance depot, \$18,200;  
 For one stable, with carriage house, \$5,000;  
 For three sets of family quarters for Ordnance machinists, one each at Forts Randolph, Sherman, and Grant, \$7,800;  
 For one dock, \$160,000;  
 For necessary dredging, \$100,000;  
 For necessary railroad tracks and connections, \$17,500;  
 For roads, walks, sewers, water, light, and power, \$25,000;  
 In all, \$533,000, to continue available until expended.

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#### UNITED STATES EMPLOYEES' COMPENSATION COMMISSION.

For expenses under an Act entitled "An Act to provide compensation for employees of the United States suffering injuries while in the performance of their duties, and for other purposes," approved September seven, nineteen hundred and sixteen, namely:

MISCELLANEOUS EXPENSES: For salaries of the commissioners, and for such assistants, clerks, and other employees, as the Commission may deem necessary, and for traveling expenses, expenses of medical examinations, and for reasonable traveling and other expenses and loss of wages payable to employees under section twenty-one, for rent in the District of Columbia and equipment of offices, purchase of books, stationery, and other supplies, printing and binding to be done at the Government Printing Office, and other necessary expenses, for the fiscal year nineteen hundred and seventeen, \$50,000. Estimates in detail shall hereafter be annually submitted hereunder.

EMPLOYEES' COMPENSATION FUND: For the payment of compensation provided by said Act, including medical, surgical, and hospital services, and supplies provided by section nine, and the transportation and burial expenses provided by sections nine and eleven, for the fiscal year nineteen hundred and seventeen, \$500,000.

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Approved, September 8, 1916.

#### EXECUTIVE ORDER.

By direction of the President, it is ordered:

1. That the Joint Commission for the appraisalment and settlement of damages to property in the Canal Zone, established in accordance with the provisions of the Canal Convention between the United States and Panama, concluded November 18, 1903, is hereby authorized, with the approval of the Secretary of State of the United States and the Panamanian Executive, to take a recess of not exceeding sixty days in each fiscal year, and the members thereof, or any of them, may be granted a leave of absence during the recess of the Commission, by their respective Governments.

2. That payment for any absence of a member of the Commission, due to illness or injury, shall be made upon the certificate of a physician in the employ of The Panama Canal that such absence is due to illness or injury.

3. That payment for leave of absence granted under the provisions of this order during the recess of the Commission shall be made at the rate of Fifteen Dollars (\$15.00) per day.

4. That payment for absence, whether granted as leave in conformity with the provisions of this order, or whether due to illness or injury, shall not be made for more than sixty days in one fiscal year.

5. That no payment shall be made for any days during which the members of the Commission may be absent from duty except as authorized by this order, and except to the American Commissioners for the time required for them to return to New York upon the termination of their services.

LINDLEY M. GARRISON,  
Secretary of War.

WAR DEPARTMENT, October 16, 1915.

#### EXECUTIVE ORDER.

By direction of the President, it is ordered:

That Clement L. Bouvé, who has been appointed a member of the Joint Commission for the appraisalment and settlement of damages to property in the Canal Zone, in accordance with the provisions of Article Six and Fifteen of the Convention between

the United States and Panama, concluded November 18, 1903, be allowed Twenty-five (\$25) dollars per day for his services, including all expenses, from the time of his sailing from New York until his return thither; provided that he shall be granted free transportation on the Panama Railroad Steamship Line from New York to the Isthmus and return, free transportation over the Panama Railroad, and such other transportation as may be necessary when traveling on official business on the Isthmus; he shall also be allowed the ordinary privileges of Government employees on the Isthmus, including employees' rates at the hotels of The Panama Canal or the Panama Railroad Company on the Isthmus.

NEWTON D. BAKER,  
*Secretary of War.*

WAR DEPARTMENT, *Washington, D. C., March 25, 1916.*

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EXECUTIVE ORDER.

By direction of the President it is ordered that Señor Don Victor Maria Concas Palau, Vice Admiral of the Spanish Navy, who has been appointed Umpire in virtue of the provisions of articles VI and XV of the Treaty of November 18, 1903, between the United States and the Republic of Panama in the settlement of certain claims which have come before the Joint Commission provided for in those articles, and in which the Commission has failed to render a decision owing to disagreement, be allowed Ten Thousand Dollars (\$10,000.00) per annum for his services including all expenses from the time of his sailing from Spain to his return thither, provided that he shall be reimbursed for his steamship transportation from Spain to the Isthmus and return except that should he elect not to return to Spain by the most direct route he shall be paid his salary for a period equal to that for which he would have been paid had he returned to Spain by direct route, and he shall be paid a sum equal to that which he would have expended for transportation had he returned to Spain by direct route; he shall be allowed free transportation over the Panama Railroad, and such other transportation as may be necessary when traveling on official business on the Isthmus; he shall also be allowed the ordinary privileges of government employees on the Isthmus including employees' rates at the hotels of The Panama Canal or the Panama Railroad Company on the Isthmus.

NEWTON D. BAKER,  
*Secretary of War.*

WAR DEPARTMENT, *Washington, D. C., 13 May, 1916.*

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EXECUTIVE ORDER.

Under the provisions of the Panama Canal Act the Governor is charged with the protection of the Canal until such time as the President may designate an officer of the Army to have entire control of the Canal and the Canal Zone during time of war or threatened war. The military and naval forces stationed in the Canal Zone will furnish such assistance to the Governor in the performance of this duty as the respective commanding officers may be requested by him to render.

WOODROW WILSON.

THE WHITE HOUSE, *17 May, 1916.*

[No. 2382.]

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EXECUTIVE ORDER.

Mr. Warren J. Brown, Mr. Henry C. Mansfield, and Mrs. Florence E. Cleveland may be appointed as clerks in the classified service of the Government without reference to the civil service rules.

This order is issued upon the recommendation of the Secretary of War, who submits a detailed report from the Governor of The Panama Canal, giving special reasons as to why the same should be issued, in view of which it is believed that the appointment of these three persons will be in the interest of the service. From the Governor's report it appears that Messrs. Brown and Mansfield have rendered long and very satisfactory service in the employment of the Government on the Isthmus of Panama; and that Mrs. Cleveland, whose husband was killed May 23, 1914, while employed as

an operator of one of the towing locomotives of the Panama Canal, has been employed in an excepted position in the Panama Canal service since November 16, 1914, in which position it appears she has rendered very satisfactory service.

The Civil Service Commission does not concur in the recommendation.

WOODROW WILSON.

THE WHITE HOUSE, 30 June, 1916.

[No. 2410.]

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#### EXECUTIVE ORDER.

ESTABLISHING regulations providing conditions under which The Panama Canal and the Panama Railroad Company employees on the Isthmus of Panama, may be allowed the use of quarters, fuel and electric current.

By virtue of the authority vested in me, and The Panama Canal Act approved August 24, 1912, it is hereby ordered:

1. That the Executive Order of January 15, 1915, No. 2120, is hereby rescinded and abrogated.

2. That effective July 1, 1916, officers and employees of The Panama Canal and the Panama Railroad Company on the Isthmus of Panama, shall be allowed, where available, quarters free of rent, and shall be furnished fuel and electric current free.

3. That the Governor of The Panama Canal is hereby authorized to assign to officers and employees of The Panama Canal and of the Panama Railroad Company, such quarters as may be available for occupancy, and to make all rules and regulations necessary to govern the assignment and occupancy of such quarters, including rules and regulations relative to the furnishing of fuel and electric current to officers and employees of The Panama Canal and the Panama Railroad Company while occupying such quarters.

4. That officers and employees of The Panama Canal and the Panama Railroad Company, for whom quarters are not available or who do not occupy such quarters as may be assigned to them by the Governor of The Panama Canal, shall have no claim against the Government of the United States for commutation of quarters not furnished or not occupied, nor for fuel and electric current not furnished.

5. That all rules and regulations governing the assignment and occupancy of quarters heretofore promulgated by the Governor of The Panama Canal or the Isthmian Canal Commission, not inconsistent with the provisions of this Executive Order, are continued in full force and effect until such time as they may be changed by regulations promulgated by the Governor of The Panama Canal under authority of this Executive Order; and all rules and regulations heretofore promulgated by the Governor of The Panama Canal in connection with the use and occupancy of quarters and the furnishing of fuel and electric current to officers and employees of The Panama Canal and the Panama Railroad Company, inconsistent with the provisions of this Executive Order, are hereby rescinded and abolished.

WOODROW WILSON.

THE WHITE HOUSE, 25 July, 1916.

[No. 2428.]

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#### EXECUTIVE ORDER.

MODIFICATION of Executive Order No. 2428, dated July 25, 1916, establishing regulations providing conditions under which the Panama Canal and the Panama Railroad employees on the Isthmus of Panama may be allowed the use of quarters, fuel and electric current.

By virtue of the authority vested in me by the Panama Canal Act approved August 24, 1912, it is hereby ordered:

That the provisions of Executive Order No. 2428, dated July 25, 1916, shall not apply to alien silver employees. Such employees shall be charged for quarters, fuel and electric current in accordance with such rules and regulations heretofore or hereafter promulgated by the Governor of the Panama Canal.

WOODROW WILSON.

THE WHITE HOUSE, 10 August, 1916.

[No. 2440.]

## EXECUTIVE ORDER.

RELATING to Motor Vehicles, and Their Operation in the Roads of the Canal Zone.

By virtue of the authority vested in me I hereby establish the following Executive Order for the Canal Zone:

Section 1. There shall be collected on motor vehicles owned by residents of the Canal Zone and operated therein, an annual license fee as follows:

For each passenger automobile for personal use only, five dollars (\$5.00).

For each automobile of twenty-nine horse-power or less, used for carrying passengers for hire, twenty dollars (\$20.00).

For each automobile of more than twenty-nine horse-power, used for carrying passengers for hire, thirty dollars (\$30.00).

For each truck or omnibus of one-ton capacity or less, twenty dollars (\$20.00).

For each truck or omnibus of a capacity of more than one ton but less than three tons, thirty dollars (\$30.00).

For each truck or omnibus of a capacity of three tons or more, forty dollars (\$40.00).

For each motor-cycle, two dollars (\$2.00).

In case of a dispute as to the horse-power or capacity of a vehicle, the issue shall be referred to the Board of Local Inspectors, and the decision of the Board thereon shall be final.

License fees shall be paid for the calendar year; but if any part of the calendar year shall have expired when the license is taken out, then the license fee to be paid shall be proportioned to the part of the calendar year remaining, including therein the calendar quarter in which the license is paid; but the Governor shall have authority to issue short-term licenses at rates proportionate to the rates in the above schedule, in such special cases as he may deem proper.

Licenses heretofore issued shall continue in force, and the licensees shall not be required to pay fees hereunder until the licenses previously issued to them shall have expired.

Section 2. Motor vehicles owned by residents of the Republic of Panama and operated in the Canal Zone, shall pay the same annual license fee as is imposed by the Republic of Panama on motor vehicles owned by residents of the Canal Zone and operated in the Republic of Panama; *Provided*, That the Governor of the Canal Zone may enter into arrangements with the authorities of the Republic of Panama by which any class or classes of vehicles owned by residents of the Canal Zone and operated in the Republic of Panama may be exempted from the payment of license fees in the Republic of Panama, or required to pay fees at a reduced rate, and any class or classes of vehicles owned by residents of the Republic of Panama and operated in the Canal Zone may be exempted from the payment of license fees in the Canal Zone, or required to pay fees at a reduced rate.

Section 3. The Governor of the Canal Zone is hereby authorized to exempt from the payment of license fees hereunder motor vehicles operated exclusively within certain areas or districts of the Canal Zone to be defined by him, and the Governor is also authorized by public notice to prohibit motor vehicles of any or all kinds from operating on such portions of the roads in the Canal Zone as he may designate, when, in his judgment, the public interest requires it; or he may permit any of said vehicles to be operated in any areas or districts designated by him, upon such conditions as he may deem necessary and convenient for the welfare of the Panama Canal.

Section 4. The use of flare lights on vehicles, within the limits of any city, town, or village in the Canal Zone is hereby prohibited; and on roads outside of any city, town, or village limits, the drivers of automobiles and motor-cycles shall extinguish their flare lights at least one hundred and fifty (150) feet from an approaching vehicle, and shall pass such approaching vehicle with the use of their dimmer lights only.

Section 5. Section 1 of the Executive Order of February 28, 1912, No. 1489, relating to motor vehicles, is hereby amended to read as follows:

Section 1. It shall be unlawful to drive or operate a motor vehicle or bicycle over the roads of the Canal Zone outside of town or village limits, at a speed exceeding twenty-five (25) miles an hour on straight roads, or at a speed exceeding twelve (12) miles an hour when approaching or traversing curves, forks, or cross roads, or when traveling over the streets of any city, town, or village of the Canal Zone, or when approaching another vehicle. The owner of an automobile, if within the car, shall be held responsible for its speed. In the absence of the owner the person actually operating the automobile shall be held responsible. The person operating a motor-cycle or bicycle shall be held responsible for its speed.



Section 6. Any person violating any of the provisions of this order shall be punished in the manner prescribed in Section 5 of the Act of Congress, approved August 21, 1916, and entitled: An Act Extending certain privileges of canal employees to other officials on the Canal Zone and authorizing the President to make rules and regulations affecting health, sanitation, quarantine, taxation, public roads, self-propelled vehicles, and police powers on the Canal Zone, and for other purposes, including provision as to certain fees, money orders, and interest deposits.

Section 7. This Order shall take effect on and after October 1, 1916.

WOODROW WILSON.

THE WHITE HOUSE, 5 September, 1916.

[No. 2451.]

#### EXECUTIVE ORDER.

TRANSFERRING to the Governor of The Panama Canal the administration of the Act approved September 7, 1916, so far as Panama Canal and Panama Railroad employees are concerned.

By virtue of the authority vested in me by Section 42 of the Act entitled "An Act to provide compensation for employees of the United States suffering injuries while in the performance of their duties, and for other purposes," approved September 7, 1916, it is hereby ordered:

1. That the administration of the Act entitled, "An Act to provide compensation for employees of the United States suffering injuries while in the performance of their duties, and for other purposes," approved September 7, 1916, so far as employees of The Panama Canal and of the Panama Railroad Company are concerned, is hereby transferred to the Governor of The Panama Canal.

2. That in the case of compensation to employees of The Panama Canal, or of the Panama Railroad Company, for temporary disability, either total or partial, the Governor of The Panama Canal is hereby authorized to waive, at his discretion, the making of the claim required by section eighteen of said Act.

3. That in the case of alien employees of The Panama Canal, or of the Panama Railroad Company, the minimum limit established by section six on the monthly compensation for disability, and the minimum limit established by clause (K) of section ten on the monthly pay on which death compensation is to be computed, is hereby removed.

4. That the Governor of The Panama Canal is hereby authorized to pay the compensation provided by said Act, including the medical, surgical, and hospital services and supplies provided by section nine and the transportation and burial expenses provided by sections nine and eleven, out of the appropriations for The Panama Canal, such appropriations to be reimbursed for such payments by transfer of funds from the employees' compensation fund.

WOODROW WILSON.

THE WHITE HOUSE, 15 Sept., 1916.

[No. 2455.]

#### EXECUTIVE ORDER.

AUTHORIZING the commutation of leave privileges in certain cases.

By virtue of the authority vested in me, I hereby establish the following Executive Order:

The leave privileges accrued in favor of an employee of The Panama Canal, the Canal Zone, or the Panama Railroad, may be commuted in cash, in conformity with existing rules and regulations, notwithstanding the employee shall not have completed ten months service at the time such commutation is made, in all cases in which such employee is transferred to the Fortification work on the Isthmus of Panama under the Chief of Engineers of the United States Army; and such employee shall be entitled to receive in cash the amount due him for such accumulated leave, on the basis of one-twelfth of the annual allowance of cumulative and annual leave for each full month served for which leave has not been granted.

WOODROW WILSON.

THE WHITE HOUSE, 17 October, 1916.

[No. 2475.]



## EXECUTIVE ORDER.

PROVIDING for the payment of interest on Deposit Money Orders issued in the Canal Zone.

By virtue of the authority vested in me by law, it is hereby ordered:

1. That deposit money orders issued by the Canal Zone Postal Service shall bear interest at the rate of one-half of one percentum for each period of three full calendar months, from August 21, 1916, or subsequent date of issue. Interest shall be payable when the order is paid but shall not accrue on any order for more than three years.

2. The Governor of The Panama Canal is authorized to prescribe such detailed rules and regulations as may be necessary to carry out this order.

WOODROW WILSON.

The WHITE HOUSE, 22 October, 1916.

[No. 2479.]



## APPENDIX R.

### CHARTS SHOWING ORGANIZATION OF THE PANAMA CANAL AND PANAMA RAILROAD COMPANY, JULY 1, 1916.

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